BANGALORE WATER SUPPLY
AND SEWERAGE BOARD
CAUVERY BHAVAN, KEMPEGOWDA ROAD
BANGALORE - 560 009

Telephone: 91-80-22945108 Fax: 91-80-22945108

Through Karnataka Public Procurement Portal

KARNATAKA WATER SECURITY AND DISASTER RESILIENCE PROGRAM (KWSDRP)

TENDER FOR THE WORK OF

PROCUREMENT AND CONSTRUCTION OF RISINH MAIN, MAIN SEWERS AND LATERALS INCLUDING MACHINE HOLES FOR BYATARAYANAPURA ZONE (ITEM RATED) IN 110 VILLAGE AREAS (Phase II) UNDER KARNATAKA WATER SECURITY AND DISASTER RESILIENCE PROGRAM (KWSDRP) – (Contract Package No. BWSSB CE-P/KWSDRP/WBS-II-B)

VOLUME 2 of 4 (Technical Specifications and Technical Schedule)

APRIL – 2025

Office of the *Chief Engineer (Project)*
BANGALORE WATER SUPPLY & SEWERAGE BOARD
3rd Floor, Cauvery Bhavan,
K.G. Road,
Bangalore -560 009
www.kppp.karnataka.gov.in

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PART 1

PROJECT DETAILS

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PART 1

PROJECT DETAIL

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PART-1

PROJECT DETAILS

1.1 Background to the Project

Bangalore is experiencing unprecedented rapid growth in the field of Industrial, Commercial, and Institutional sectors. This phenomenal growth has led to unplanned urban development surrounding Bangalore, resulting in an increase in population and construction activities. Furthermore, with the inclusion of 110 Peripheral villages in BBMP, the population of Bangalore city has increased by 50% over the last decade, i.e., from 8.5 million (2011) to 12.765 million (2021). The 110 Villages located in the periphery of the Bruhat Bangalore Mahanagar Palike, with an area of about 225 sq. km, are experiencing rapid growth, demanding basic infrastructure. This sudden growth in population in the peripheral area is posing tremendous pressure on basic infrastructure, especially on the Water Supply and the Underground Sewerage system. This has also resulted in urban flooding and the entry of sewage into lakes, polluting the water bodies situated in 110 villages.

To facilitate the UGD facilities (laterals) to 110 villages located in the periphery of BBMP, covering an area of approximately 225 sq. km, BWSSB had undertaken and completed the work of providing a UGD network (laterals) with financial assistance from the Government of Karnataka. Furthermore, to convey and treat the sewage from these laterals under the JICA-funded Cauvery stage V project, construction of 14 No. STPs of various capacities totaling 124 MLD are taken up along with laying of sub-mains and trunk sewers. Accordingly, works were undertaken in the R.R. Nagar, Dasarahalli, Byatarayanapura, Mahadevapura, and Bommanahalli zones.

Despite providing UGD network and sewage treatment system to 110 villages, due to exponential growth between planning and execution of projects, fund constraints, and the addition of new areas require additional infrastructure to service the newly added areas.

Thus, to provide the UGD facilities in a comprehensive manner, BWSSB has proposed the following works under the Karnataka Water Security and Disaster Resilience Program (KWSDRP) through the Government of Karnataka with financial assistance from the World Bank. Accordingly, the Government of Karnataka cabinet has accorded administrative approval for the implementation of the project on 05.03.2025. This Project is under performance for Results (P for R) considering various initiatives taken up by the BWSSB in the field of Sewerage System.

The entire project area is divided as shown below based on the topography and natural drainage pattern of the drainage zone of the 110 villages:

Contract Package	Catchment	Drainage Zone
WBS-1	V Valley	RR Nagar & Dasarahalli
WBS-2a	Hebbal Valley	Byatarayanapura- WwTP
WBS-2b	Hebbal Valley	Byatarayanapura- UGD Network
WBS-3	K & C Valley	Bommanahalli
WBS-4	K & C Valley	Bommanahalli
WBS-5	K & C Valley	Mahadevapura

1.2 Works Details for Contract Package WBS 2b

Works : Procurement & Construction of Main sewers & laterals including Machine holes and Pumping mains.

1.3 Components List for Work

The Proposed Sewer network system is in the catchment area of Hebbal Valley & in the drainage zone of Byatarayanapura.

The following table shows the details of the pumping main from Bellahalli ISPS and this pumping main is proposed for the year 2054 projected flows:

S.No	Pumping Main		Diameter (mm)	Length (m)
	From	To		
1	Bellahalli	To Ridge Machine hole	250	3000

Notes:

1. *Length may be subject to adjustment during Contract based on topographic survey and other factors.*

Following table shows the details of the gravity sewer mains with machine holes and these sewer mains are proposed for the year 2054 projected flows.

S. No.	Zone Name	Diameter (mm)				Total Length of Sewer Network (m)	No. of Machine holes
		250 (DWC) (m)	300 (DWC) (m)	300 (RCC NP-3) (m)	400 (RCC NP-3) (m)		
1	Byatarayanapura	173000	6400	10000	3600	193000	6070
	Total	**173000**	**6400**	**10000**	**3600**	**193000**	**6070**

Notes:

1) *Length and number of Machine holes may be subject to adjustment during implementation of Contract based on confirmatory topographic survey and other factors.*

1.4 Scope of Work

The scope of work includes procurement, laying, testing, and commissioning of sewer laterals and mains at Byatarayanapura zones. The scope also covers the associated civil works, including the construction of machine holes, saddle supports, pipe encasement and anchor blocks.

The sewer line will be laid through urban areas, wherein frequent bends, conflict with other utilities might encountered along the right of way. A right of way to lay the sewer line shall be obtained in places, where the service road or land is not readily available.

The major length of sewer line is proposed to be laid underground. The exposed portion is to be laid above ground supported on saddles/ bridges. Some short lengths of sewer line laid underground needs concrete encasement while crossing the existing roads as well as at places of higher soil over burden.

Sewer line crossing major roads shall be laid using trenchless technology.

The Scope of Work under this contract includes but is not limited to the following in relation to Work:

- Identification of Sewer line Gaps in 110 villages Sewer network in Consultation with the Engineer In-charge for Conducting Survey.
- All preparatory work including clearing and leveling of site, site grading, formation of finished ground level (FGL), excavation, dewatering as required and disposal of all surplus earth to a suitable location and restore all the cutting roads to the original condition complete.
- Necessary Sewer alignment survey and geotechnical investigations and any other site investigations / site data complete including providing interconnecting existing machine hole & pipeline details of laterals with main sewers.
- Collection of details of existing machine holes between Gaps to facilitate design of sewer network.
- Collection of details of existing ISPS/TSPS for design of Sewer network.
- Existing utility survey has to be done wherever required. The contractor is required to carefully examine the location of the works & their alignments and to make special enquiries with all authorities concerning all Utility lines such as water, sewers, gas pipe, telephone (underground and overhead) lines, electric lines etc., and to determine and verify to his own satisfaction the types of materials Sizes, position and lengths of such utilities from authentic records. The Contractor shall be wholly responsible for the protection and facilitating relocation of such utilities as may be required.
- Submission of all Vendor Credentials & Quality assurance plans to obtain approval from competent authority before procurement of any type of materials & equipment.
- All utility lines and structures, whether indicated on the drawings or not, which are to remain in service shall be protected by the contractor from any damage likely to result from his operations and relocate wherever necessary, shall be with the approval of the Engineer and the Utility Authority in accordance with all applicable laws, regulations, and standards. Items, components, or materials be used should be to the satisfaction of the concerned approving authority.
- Procurement and supply of materials, and all allied accessories, including setting out, laying, jointing, testing, dewatering as required, and commissioning of the sewer networks and pumping mains of the diameters and material as specified in the tender document.
- Setting out of alignment shall be as per approved construction drawings.
- Procurement and erection of machine holes with covers and other supporting accessories complete.
- High Pressure DI Machine hole covers supplied by the department are to be installed by the contractor in storm water drains for the Machine holes.
- Construction of pipe bedding, pipe supports, thrust blocks, anchor blocks etc., complete as per Specifications & drawings.
- Road restoration works to its original condition including all allied works shall be carried out as per Specifications & drawings.
- House service connection line to be installed.
- Interconnections with other works as required to complete the work.
- Handing over of constructed facilities.
- Preparation and Submission of As-Built Drawings.

Notes:

- *Contractor shall carry out the complete survey of sewer networks as directed by the Engineer and shall submit the same data, village-wise and drainage zone-wise, to the Employer.*
- *Good for Construction Drawings (PDF files) issued by the Consultant shall be printed by the Contractor (A1 Drawings) as per the requirement of the Engineer In-charge, and the same shall be submitted to obtain necessary approval from the competent Authority.*
- *The Contractor shall submit Eight (8) copies of each design and drawing to the Employer for approval.*
- *Any crossing of the gravity sewer lines & pumping mains across National Highway, State Highway, Heavy traffic roads, and Railways shall be carried out with trenchless technology and with prior approval from the concerned authority in accordance with all applicable laws, regulations, and standards complete.*
- *Contractor to submit Construction Approach and Methodology, before the start of each/any type of construction activity at the site.*
- *It shall be mandatory for Contractor to take prior approval on EMP and EMoP document based on the requirements as specified in Part 18 of the Tender Document.*
- *Contractor is responsible for liaisoning with external agencies like BBMP/BESCOM/Traffic Police etc.,*
- *Preliminary Data provided in the Tender Document is only for Guidance Purpose same required to be verified by the contractor upon visiting the site.*

1.5 Funding Agency and Financing

Funds for the Contract are being provided by the World Bank and State Government of Karnataka.

1.6 Site Conditions

Each Plant shall be designed and constructed taking into account the following:

Annual Average Ambient Temperature	:	27^{o} C (Minimum 15^{o}C - Maximum 45^{o} C)
Relative Humidity (maximum)	:	75 %
Site Conditions	:	Tropical

The plant shall be designed to suit the ambient temperature mentioned above with the Contractor making due allowance in his designs for the increased temperatures experienced by Plant exposed to direct sunlight.

1.7 Access for Other Contractors

The Contractor shall allow reasonable access to other Contractors engaged on the Site or on areas adjoining the Site to carry out their work. In the event of a dispute over access or priority between Contractors, the Engineer shall be informed in writing. The Engineer shall inform all parties concerned in writing of his decision.

Where any part of the Works is associated with or in physical contact with plant supplied under a separate contract, the Contractor shall satisfy himself that the work carried out by the other Contractor is consistent with the correct operation of the Plant. In the event of the Contractor considering any work being carried out or any work already completed to be detrimental to the ultimate operation of the Plant, he shall report the matter to the Engineer.

If the work of the Contractor is delayed because of any acts or omissions of any other contractor, the Contractor shall have no claim against the Employer on that account other than for an extension of time.

Works of other Contracts taking place on the same Site or adjoining the Site include but are not limited to the following:

1. Providing and laying laterals sewers and house connection chambers for 110 Villages;
2. Regular operation and maintenance work of existing sewers, ISPS, TSPS and STPs by BWSSB.

1.8 Survey and Geotechnical Data

Contractor shall carry out independently fresh survey, geotechnical investigation and all other details necessary for proper planning, detailed design and execution of all works under this Contract. The Contractor will be required to provide full details of the survey and geotechnical investigations of works for approval of the Employer.

1.9 Battery Limits

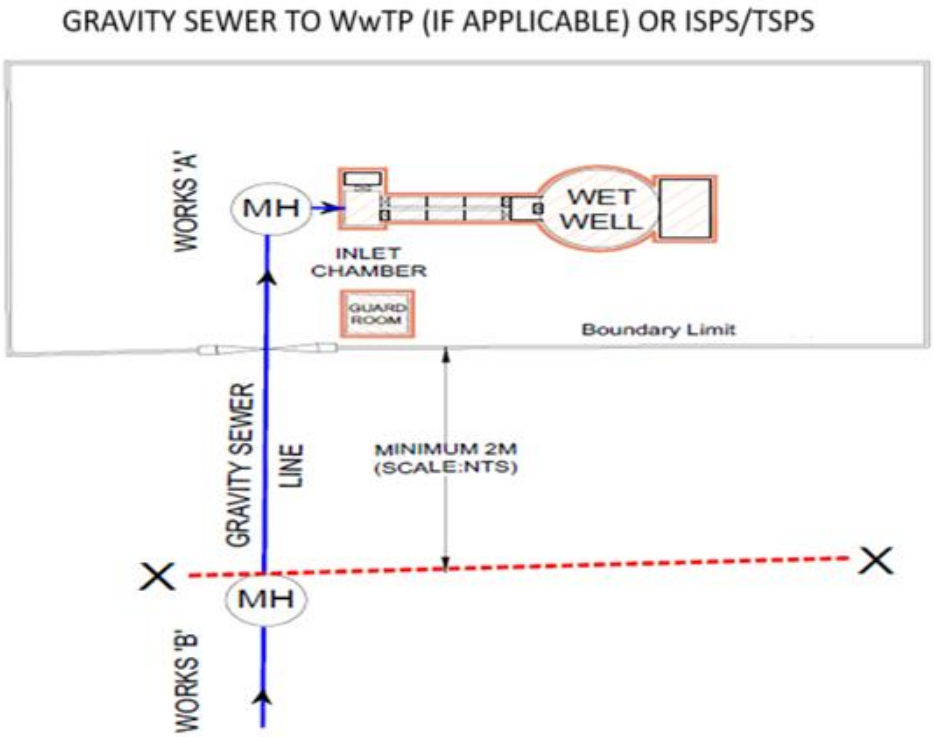
The following are the Battery Limits (interfaces between) Works:

Works – A (WwTP/TSPS/ISPS) – Other Contract
Works – B (Sewer Network / Rising Main) – This Contract

Gravity Sewer to WwTP (if applicable) or ISPS/TSPS

The interface between Works – A and Works – B shall be the first flexible joint downstream of the machine hole outside of the WWTP Site (Line XX on the following Figure). The machine hole shall be located such that the edge of the machine hole is located minimum 2 m from the centre of the fence or wall (which shall be constructed along the boundary of the Site for Works - A in which the TSPS/ISPS and WWTP shall be constructed), whichever is provided.

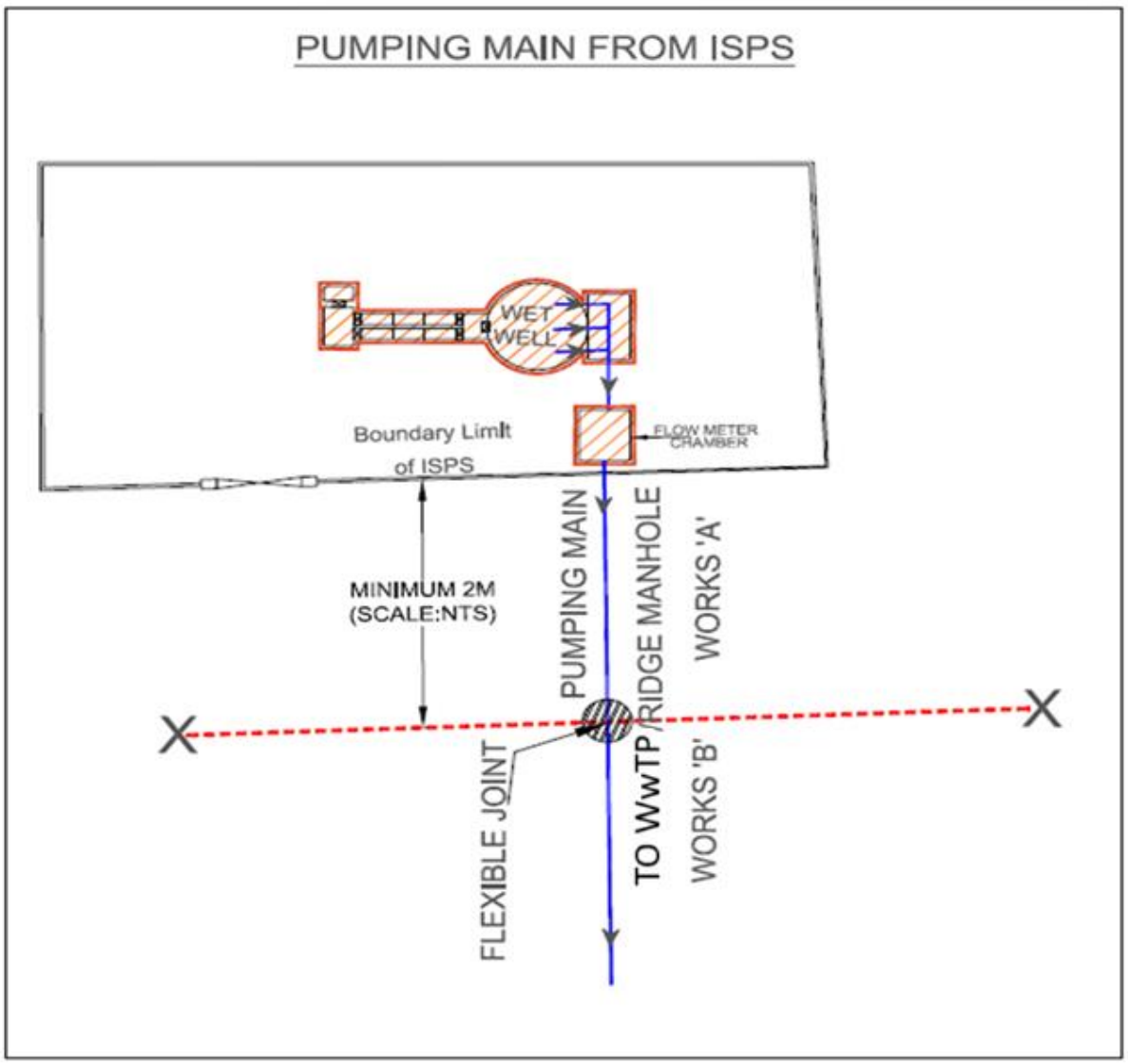
Works downstream of Line XX shall be included in Works – A, whereas Works upstream of Line XX shall be included in Works – B. For clarity Works in Works – A therefore includes a short length of sewer, which is outside the boundary of the Site for Works – A, as described in the above paragraph.



Pumping Main from ISPS

The interface between Works – A and Works – B shall be the first flexible joint on the pumping main outside the boundary of the ISPS Site (Line XX on the following Figure). The above joint shall be located such that the centre line of the joint is located at minimum of 2 m from the centre of the fence or wall (which shall be constructed along the boundary of the Site for Works – A in which the ISPS shall be constructed), whichever is provided,

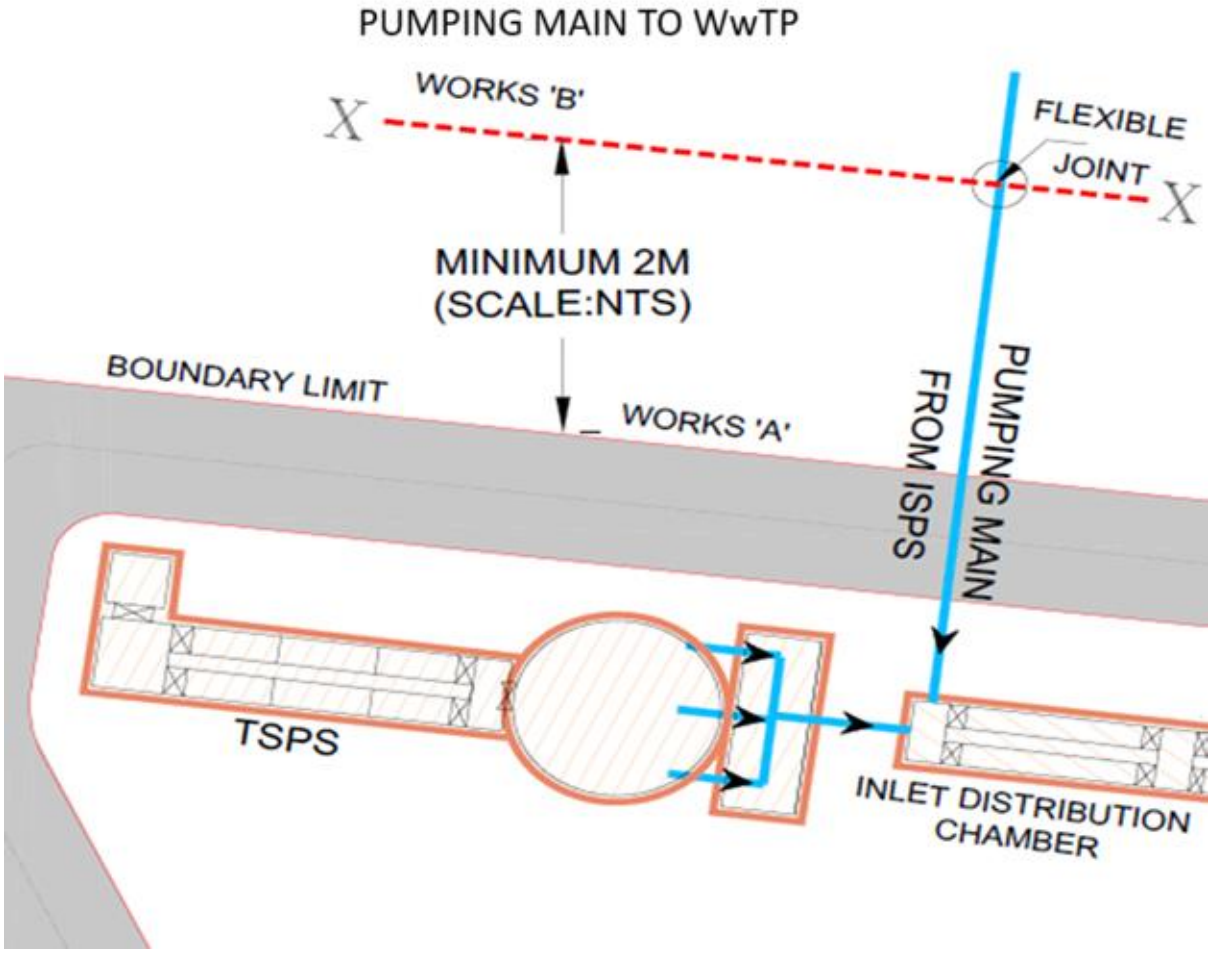
Works upstream of Line XX shall be included in Works – A, whereas Works downstream of Line XX shall be included in Works – B. For clarity Works in Works – A therefore includes a short length of Pumping Main, which is outside the boundary of the Site for Works – A, as described in the above paragraph.



Pumping main to WwTP (If Applicable)

The interface between Works – A and Works – B shall be the last flexible on the pumping main outside the boundary of the WWTP Site (Line XX on the following Figure). The above joint shall be located such that the centre line of the joint is located a minimum of 2 m from the centre of the fence or wall (which shall be constructed along the boundary of the Site for Works – A in which the WWTP shall be constructed), whichever is provided.

Works upstream of Line XX shall be included in Works –B, whereas Works downstream of Line XX shall be included in Works –A. For clarity Works in Works – A therefore includes a short length of Pumping main, which is outside the boundary of the Site for Works – A, as described in the above paragraph.



Connections to Existing Facilities under Works - B

Connections of Proposed Sewers to Existing Machine holes

All sewers shall be connected to existing machine holes and not directly to the sewer in accordance with the levels and other details provided by the Engineer.

The Contractor shall carry out all works such that there is no adverse effect on the flow in the machine hole that the sewer is to be connected to, as well as all sewers upstream and downstream of the machine hole. Works shall preferably be carried out when flows in the existing sewer are low compared to the average flow. All work shall be carried out without effecting the structural integrity, water tightness or other requirements/features relating to the construction of a new machine hole.

Works shall include but not be limited to: breaking existing machine holes (including for connection of backdrop, where required); connection of new pipes, making good and sealing; breaking existing benching, construction of new benching and making good; removal of existing step irons and installation of new step irons, where required due to orientation/location of new sewer; relocation of machine hole cover, where required due to orientation/location of new sewer.

Connections of Proposed Pumping Mains to Existing Machine holes

Connections shall be made as described for Connections of Proposed Sewers to Existing Machine holes.

1.10 Interface with Other Contracts

The Works under this Contract will physically interface with Works under the Contract for laying lateral sewers for 110 villages. The Contractor for this contract shall co-ordinate with Employer and the Contractors for the above Contract as applicable and ensure that all interfaces are designed, constructed, installed, tested, commissioned, operated, and maintained properly to provide a fully functional system meeting all applicable performance requirements.

The Contractor for this Contract shall be fully responsible for independently field-verifying any and all information he considers relevant in order to provide a fully functional system.

1.11 Sectional Completion of Works

Sectional Completion of Works is required by the Employer and is included in Volume 1 of the Tender Document. The Contractor shall in particular note the importance and sequence of Sectional Completion considering also the interface between existing facilities and those being implemented under a separate Contract.

The Contractor should note that the lateral sewers of 110 villages, which discharge sewage to the main sewers to be implemented under this Contract are being implemented under a separate contract, which is either in progress or completed. The Contractor shall familiarize himself with the schedule for the above Contract and monitor the progress on a regular basis.

In the event that construction of the TSPS/WwTP/ISPS is completed before wastewater is available at a TSPS/WwTP/ISPS, the Contractor shall properly maintain the TSPS/WwTP/ISPS in an inactive state until such time as wastewater becomes available. Further, all the components of the plant shall be adequately secured, protected, maintained, and exercised according to manufacturers' instructions during this inactive period. This inactive period shall be considered part of the Operation and Maintenance Period.

The monthly price for maintaining each WwTP/ISPS in this contract in an inactive state shall be decided by mutual agreement between the Employer and the Contractor as necessary.

Specified activities related to commissioning, testing, demonstration of performance shall be performed when wastewater becomes available at the WwTP/ISPS. No additional payment shall be made to the Contractor for such deferred activities.

End of Part 1

PART 2

THE SITE

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PART 2

THE SITE

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PART 2

THE SITE

2.1 Location of the Sites

Proposed Sewerage System

The sewerage system under the package comprises areas falling under Byatarayanapura zones.

Details of Proposed Size and Length of Sewer for Byatarayanapura Zones

Sl. No.	Zone	Diameter	Length (m)
1	Byatarayanapura	250mm SW Line (DWC)	173000
		300mm SW Line (DWC)	6400
		300mm RCC4 (NP3)	10000
		400 mm RCC (NP3)	3600
		Grand Total Length	**193000**

2.2 Access to the Sites

The Employer will afford to the Contractor access to and possession of the Site for carrying out the Works. The Contractor shall be deemed to have inspected the WwTP/ISPSs/, sewer network sites, including access, before submitting their Bid.

The Contractor shall ensure that equipment used for installation purposes shall be able to gain access and position for such purposes.

2.3 Maintenance of the Site

The Contractor shall be responsible for maintaining all the site structures, buildings, equipment, contract display board, and related services until expiration of the contract period or until such time as the aforementioned facilities are removed with the Engineer's prior approval, whichever is earlier.

2.4 Areas outside the Site

In the event of the Contractor making use of any special or temporary way leave or accommodation acquired by him or any pit for the disposal of surplus materials, or any borrow pit or quarry, he shall obtain the written consent of the owner, occupier or authority having charge of the land in which such way leave, accommodation, or pit is situated and shall make a written record, acknowledged and signed by the owner, of the condition of the surface of that land before entering thereon, with liberal use of photographs.

The Contractor shall permit the Employer, the Engineer, and any person authorised by the Employer access for the purposes of the Contract to any such special or temporary way leave or additional accommodation.

In the event of the Contractor making use of any special or temporary way leave or additional accommodation made available to him by the Employer for the purpose of the Contract, the land in which such way leave, or accommodation is situated shall be deemed to be part of the Site. On completion of the works in this area, the Contractor shall reinstate the area to its original condition to the satisfaction of the Engineer. For the purposes of this Clause, "accommodation" shall be deemed to include housing, offices, workshops, warehouses, and storage areas.

2.5 Road Works

The Contractor shall obtain all necessary permits for carrying out works, such as excavation on public roads, and shall liaise with the relevant authorities regarding the timing and execution of the road works.

The Contractor shall be responsible for establishing and maintaining temporary road diversions for the duration of the road works. The road shall be kept open at all times during the road works period, and the work shall be carried out in such a manner as to minimise the disruption to traffic. The Contractor shall reinstate all roads to the satisfaction of the Engineer upon completion of the works.

2.6 Maintenance of Existing Access Roads

The Contractor shall only use existing access roads within the Site boundary which are necessary for the execution of the Works. The Contractor shall obtain the Engineer's approval in writing before utilising existing access roads within the Site. Once the Engineer's approval has been given, the Contractor shall be solely responsible for the maintenance of the existing site access roads. This responsibility shall continue until the completion of the Defects Notification Period, or an earlier date as the Engineer may advise the Contractor in writing. Such maintenance work shall include general upkeep and any necessary repairs to damaged road surfaces, pavement, drainage, associated slopes, etc., to a standard at least equal to their original condition. While carrying out such maintenance work, the Contractor shall make arrangements to maintain through passage for the Employer and their staff vehicles and also those of other contractors over these access roads. Such arrangements may include temporary diversions, all of which are subject to the approval and satisfaction of the Engineer.

The Contractor shall not run tracked or unsprung vehicles on surfaced roads without the written approval of the Engineer, who may require that planking or some other protective material be used to protect the road surface.

2.7 Clearance of the Site

The Contractor shall clear the Site to the extent required by the Engineer for checking the setting-out.

Clearance of the Site shall also include demolition and removal of all articles, objects, and obstructions which are expressly required to be cleared.

The Contractor shall ensure that the parts of the Site to be occupied by the Permanent Works are clear and shall maintain the remainder of the site as may be required for access and temporary works areas.

The Contractor shall remove the material arising from such clearance and dispose-off it in a manner and at a location that are both in compliance with all applicable laws and regulations.

The Contractor shall backfill the cavities and losses of soil resulting from clearing the parts of the Site not subsequently to be occupied by the Works, using the specified materials and procedures.

The Contractor shall not clear the Site of any existing structure(s) without the prior written instruction of the Engineer.

2.8 Clearance and Reinstatement of the Site on Completion of the Works

Upon completion of the Works, the Contractor shall clear all temporary works areas and temporary access roads, and reinstate the areas to their original condition, to the satisfaction of the Engineer.

2.9 Access for the Employer and Engineer

The Contractor shall permit the Employer, the Engineer and any person authorised by the Employer or the Engineer including workmen of the Employer, other Contractors or utility undertakings access for the purposes of the Contract to all areas of the site and to any additional accommodation or temporary way leave for the duration of the Contract period.

2.10 Water Supply at Site

The Contractor shall make his own arrangements for water supply at the site for the duration of the contract. The Contractor shall ensure the quality of the water remains suitable for the purpose for which it is intended. The Contractor shall also conduct weekly tests for water quality and comply with the quality requirements. Wastewater shall be disposed of clear of the Site to the satisfaction of the Engineer so as to maintain the hygienic condition at the site and no damage or complaint.

Exploration of groundwater for construction purposes, either directly or indirectly, is not allowed under this contract. Contractor shall take prior approval for the source of water used for construction activities, and source of such water shall not be groundwater or water designated for drinking purposes.

It is highly encouraged to use the tertiary/secondary treated wastewater for construction activities where project components (Sewer Network and Rising Main) under this contract is within 10 kms radius of existing operating WwTP(s) and such tertiary/secondary treated wastewater is available to contractor at reasonable cost from BWSSB upon request. However, the contractor shall ensure that such tertiary/secondary treated wastewater shall meet the water quality suitable for the purpose for which it is intended. Further, it is the contractor's responsibility to ensure "non-detectable Fecal Coliform" standards for tertiary/secondary treated wastewater, wherever it has the possibility of direct or indirect human contact during construction activities, by the Contractor at his own cost.

Nevertheless, at minimum, the water requirement for the Contractor's batching plant and the water requirement for hydro-test(s) shall be met by tertiary/secondary treated wastewater.

2.11 Toilets, Latrines, Washing Facilities, and Wastewater Disposal

Throughout the period of construction of the Works, the Contractor shall provide and maintain sufficient toilets, and wash facilities for use by his employees that are clean. He shall ensure that his employees make proper use of the toilets and not foul the site.

Where, all wastewater generated at the facilities on site shall be connected to the nearest public sewer, or if this is not practicable, the Contractor shall provide an adequately sized septic tank and soak pit.

After completion of the works, the temporary toilets, latrines, washing facilities, septic tanks, and soak pits shall be removed, all ground disinfected, and the surface restored to its original condition to the satisfaction of the Engineer.

2.12 Electricity for Contractor's Use on Site

The Contractor shall be responsible for the provision of an electric supply to the site, an energy meter, and the distribution of the supply in accordance with the Conditions of Contract (including Particular Conditions of Contract).

The installation shall comply with all the relevant regulations, Indian Standards and Codes of Practice, and Health and Safety requirements. The Contractor shall take all precautions to ensure that the installation is safe and injury to personnel or damage to plant and buildings is avoided. The Contractor shall be fully responsible for all safety aspects.

The Contractor shall test the temporary site power distribution system, including the energy meter, every 3 months for compliance with the relevant standards.

2.13 Camp Facilities

The Contractor shall construct and maintain to the Engineer’s satisfaction a camp to provide living accommodation for all the Contractor's staff and operatives who have no other local accommodation. The Contractor's camp shall be located near, but not on, the Site itself, at a location approved by the Engineer.

Responsibility for providing all services to the living quarters and compliance with all sanitary laws and other laws and regulations shall be borne by the Contractor. Security and the fencing of these areas shall be the responsibility of the Contractor.

2.14 Compressed Air Use on Site

The Contractor shall provide the necessary compressed air plant and equipment required for the construction of the Works.

Electrically driven compressors connected to the site electricity supply shall not be used. Diesel engine driven compressors shall not be sited within buildings or in a location that may cause a health hazard to personnel owing to exhaust fumes or noise.

2.15 Refuse Disposal on Site

Refuse and rubbish of every kind shall be removed from the Site and disposed of by the Contractor at his own expense, frequently and regularly at a minimum period of one week to keep the Site in a wholesome and tidy condition to the satisfaction of the Engineer.

2.16 Safety and Security on Site

The Contractor shall at all times maintain safe work methods and procedures and shall comply with all enactments, regulations, and working rules relating to safety, security, health, and welfare of all persons who may be affected by his work.

In particular, he shall ensure that only persons who are properly trained for their duties are employed and that appropriate, approved tools, safety equipment, and procedures are used.

Nothing which has been written into or omitted from the Employer's Requirements shall be taken to relieve the Contractor from his obligations under this clause. No clause in the Employer's Requirements shall prevent the Contractor from drawing the attention of the Engineer to any feature of the Works which is not consistent with normal safety practices nor prevent him from putting forward proposals at any time which would increase the safety of the installations.

Not later than four weeks before work commences on the Site, the Contractor shall submit to the Engineer his comprehensive plans and proposals relating to all the aspects of health and safety on the Site. The proposals shall be appropriate for all grades of labour and personnel who will work on or visit the Site on behalf of the Employer, Engineer or Contractor.

The Contractor shall appoint **Health & Safety Engineers (Accident Prevention Officers**), as stated in Volume 1, Section III of Evaluation and Qualification Criteria who shall be responsible for the implementation of site procedures as per relevant standards. The responsibilities of the above engineers shall include but not be limited to:

- safety;
- working in hazardous areas;
- permit to work;
- fire and smoking regulations;
- first aid;
- warning signs;
- trenching scaffolding and other construction structures;
- safety barriers;
- protective clothing and equipment;
- safety training;
- safety meetings and inspections;
- health and welfare.

The Engineer shall have the authority to halt any activity or work in any area where there is a breach of the published site safety rules or where health and safety is otherwise endangered.

The Contractor shall ensure that all other Contractors working on the Site also follow established health and safety procedures. The Contractor shall bring any violation of Site safety rules by others to the attention of the Engineer in writing.

2.17 First Aid and Life-saving Apparatus on Site

The Contractor shall provide on the Site such life-saving apparatus as may be appropriate and an adequate and easily accessible to workmen and all other Staff a first aid outfit/station or such outfits/station as may be required in any government ordinances, factories acts, etc, published and subsequently amended from time to time. Each station shall be properly equipped and shall be under the charge of a suitably qualified and trained staff member. In addition, an adequate number of persons who are permanently on the Site shall be instructed in their use, and the persons so designated shall be made known to all employees by the posting of their names and designations in a prominent position (positions) on the Site.

The Contractor shall arrange for medical services to be promptly available as and when necessary and shall also provide for the transport of serious cases to the nearest hospital. These and all other arrangements shall be included in the Contractor's Safety Plan.

2.18 Electrical Safety on Site

The Contractor shall be responsible for the electrical safety of all Plant and equipment supplied and installed. Whilst any equipment is being installed or tested, the Contractor shall ensure that all necessary precautions are taken to safeguard personnel working on site. If necessary, this shall include fencing off areas which are considered to pose a risk, and erecting warning notices.

The Contractor shall be responsible for ensuring that the electrical installation is carried out by suitably trained and competent personnel who execute the work in a safe manner.

The Contractor shall be responsible for the permit at site for the operation of electrical equipment installation and testing. This system shall regulate the installation, the energisation, and use of electrical Plant and equipment installed, and the method of work adopted.

2.19 Noise

The Contractor shall ensure that the operations entailed in the construction of the Works do not cause annoyance to others working on the Site or to persons living adjacent to the Site.

2.20 Warning and Safety Signs

During construction of the Works, statutory safety signs shall be adequately provided throughout the Works, both indoors and outdoors. These safety signs shall cover mandatory, prohibition, warning, emergency, fire-fighting and general notices. All signs shall be positioned around the Works at highly visible points. Provision of signs and the positions of signs shall be subject to the Engineers approval. Special attention shall be given to areas designated hazardous.

Warning signs shall be in English, Kannada and Hindi Languages.

2.21 Site Working Hours

The Site working hours are detailed in the Contract Data.

The Contractor shall not extend the working hours without the prior approval of the Engineer.

2.22 Delivery to Site

The Contractor shall be responsible for the transportation, handling, and delivery to the site of all the Plant and equipment. The proper storage and protection of all Plant and equipment at the Site shall be the Contractor's responsibility.

The Contractor shall verify all items against the packing lists immediately upon delivery to the Site and inspect for damage and shortages. Damages and shortages shall be remedied with the minimum of delay.

The Contractor may, with the prior approval of the Engineer and at no extra cost to the Employer, make arrangements for any other contractor or agent to take delivery of, unload and store the Plant on the Site on behalf of the Contractor.

All deliveries shall take place during the Contractor's normal working hours.

2.23 Protection from Weather and Storage

An area and/or building on the Site for use by the Contractor for the storage of Plant prior to erection will be subject to the Engineer's approval.

The Contractor shall provide all facilities for the safe and proper storage of Plant and equipment, as recommended by the manufacturers, with particular consideration being given to temperature, rain, sunlight, wind, and ground conditions.

The Contractor shall remain responsible to the Employer for the care and insurance of the Plant and the provisions of this Clause shall not relieve the Contractor of any of his liabilities under the Contract.

The Contractor shall lay stored Plant items out to facilitate their retrieval and use in the order as recommended by the manufacturer.

Stacked Plant items shall be protected from damage by spacers on load-distributing supports and shall be safely arranged. No metalwork shall be stored directly on the ground.

Small Plant items shall be held in suitable bins, boxes or racks and be clearly labelled.

Items of Plant shall be handled and stored so that they are not subjected to excessive stresses and so that protective coatings are not damaged.

The Contractor shall comply with the manufacturer's package and plant markings concerning the use and location of lifting slings, chains, and hooks, and all other handling, storage, protection, and installation instructions.

2.24 Contract Signboards

The Contractor shall supply and erect signboards at locations to be specified by the Engineer. The layout and dimensions of the signboards and their construction shall be to the approval of the Engineer, and the lettering in Kannada, Hindi, and English Languages shall be black on a white background.

2.25 Advertising

The Contractor shall not use any part of the Site for any form of advertising without the prior written approval of the Engineer.

End of Part 2

PART 3

GENERAL REQUIREMENTS

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PART 3

GENERAL REQUIREMENTS

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PART 3

GENERAL REQUIREMENTS

3.1 Introduction

This Part sets out the technical requirements that are general to the Contract.

3.2 Technical Standards and Regulations

Except where otherwise specified in the bid document, materials, and workmanship shall comply with the requirements of the relevant Indian Standards (hereinafter referred to as IS) issued by the Bureau of Indian Standards. Other equivalent National or International Standard Specifications such as those issued by the International Organisation for Standardisation (ISO) or the International Electrotechnical Commission (IEC) may be substituted by the Contractor (as long as they are more stringent than the equivalent IS) at the sole discretion of the Engineer or as may have been agreed in the Contract. All standards used shall be the current and latest version.

The Electrical installation shall comply with all relevant statutory regulations and standards current as of the bid date, unless otherwise specified in the Employer's Requirements. Electrical installations shall, where relevant, be in accordance with the Indian Standards Code of Practice for Electrical Wiring Installations IS 732-2019, National Electrical Code of India 2023 (SP 30), Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2023.

All materials, and equipment shall be new. All materials and workmanship not fully specified herein or covered by an approved standard shall be of such kind as is used in first class work and suitable to the climate in the project area.

Where reference is made in the Specification to a British Standard Specification (hereinafter abbreviated to `B.S.') issued by the British Standards Institution of 2, Park street, London W.I., or to an Indian Standard Specification (I.S.) issued by the Bureau of Indian Standards, (earlier known as Indian Standards Institution), Manak Bhavan, 9 Bahadur Shah ZafarMarg, New Delhi 110 002, or American Society for Testing and Materials (ASTM) issued by ASTM 1916 Race Street, Philadelphia, P.A., 19103, U.S.A. or American National Standards Institute (ANSI) issued by ANSI 1430, Broadway, New York, N.Y., 10018, U.S.A. or to any other equivalent standard it shall be to the latest revision of that Standard at the Tender opening date.

The Contractor may propose, at no extra cost to the Employer, the use of any relevant authoritative internationally recognised Reference Standard, including Indian Standard (IS) and British Standards European Norm (BS EN).

All details, materials, and equipment supplied, as well as workmanship performed, shall comply with these Standards. If the Bidder offers equipment to other Standards, the equipment/material should be equal or superior to those specified and shall be subject to approval by the Engineer and full details of the difference shall be supplied by the Contractor.

In the event of conflict between this Specification and the Codes for equipment, the most stringent provision shall govern, except as otherwise approved by the Employer. Certain Specifications issued by national or other widely recognised bodies are referred to in this Specification. Such specifications

shall be defined and referred to hereinafter as Standard Specifications. In referring to the Standard Specifications, the following abbreviations are used:

IS	:	Indian Standard
ANSI	:	American National Standards Institute
API	:	American Petroleum Institute
ASME	:	American Society of Mechanical Engineers
ASTM	:	American Society of Testing and Materials
AWS	:	American Welding Society
AWWA	:	American Water Works Association
ISO	:	International Organization for Standardization
JIS	:	Japanese Industrial Standard
DIN	:	Deutsches Institut für Normung
BS	:	British Standard
JWWA	:	Japanese Water Works Association
IEC	:	International Electrotechnical Commission
IEE	:	Institution of Electrical Engineers
IEEE	:	Institute of Electrical and Electronics Engineers
NEMA	:	National Electrical Manufacturers Association
AGMA	:	American Gear Manufacturers Association

3.3 Precedence of Employer's Requirements

The Requirements specified in the particular requirements part, shall be in addition to those specified in the general requirements part. In the event of a conflict between the parts, the requirements of the particular requirements sections shall take precedence.

3.4 Units of Measurement

All designs, drawings, specifications, and manuals shall use SI units, and all measurements, dimensions, and performance data shall be quoted in those units.

3.5 Programme

In accordance to Volume 1 of the Particular Conditions of Contract, the Contractor shall submit within the stipulated time a detailed contract programme for approval, which shall include details of all temporary and permanent works, construction procedures and methodologies.

In addition to the requirements set down in the Conditions of the Contract the programme shall include the following details:

(a) Contractor's organisational family tree for the Contract, including details of all site supervisors and their responsibilities.

(b) A statement giving the numbers and categories of supervisory and technical staff and skilled and unskilled labour to be employed on the Works.

(c) A list and type details of major construction items (including vehicles) which the Contractor proposes to employ on the Works, including programmed dates for order and delivery.

(d) Details of the Contractor's methods of working for all operations.

(e) A statement giving the proposals for location or locations and sizes of offices, workshops, and stores at the Site.

(f) A complete resource allocation showing the number of units and allotted times for each unit of construction item, materials, and labour allocated to each part of the Works.

The programme shall be co-ordinated to take into account the requirements of climatic, groundwater, and other conditions to provide for the completion of the Works per the Contract.

The programme shall be prepared using MS Project software and shall be submitted in both soft copy (editable copy) and paper.

3.6 Contract Management

The Contractor shall be responsible for the administration of the Contract from the award of the Contract through design, manufacture, manufacturer's works testing, and delivery of the materials to the Site, installation, testing, and performance testing to final takeover. For this purpose, he shall nominate a Contractor's Representative in accordance with Volume 1 of the General Conditions of Contract, who shall be fully responsible for and undertake this administration.

Specific responsibilities of the Contractor's Representative shall be:

(a) The sole representation on behalf of the Contractor in all discussions, correspondence and matters relating to the Works.

(b) The co-ordination and monitoring of Contract progress, which shall include the preparation of the Contract programme, monitoring of progress, and submission of monthly progress reports. At the discretion of the Engineer, regular meetings shall be held at which the Contractor's Representative shall provide a full account of the Contract's progress and programme.

(c) The co-ordination and checking of designs, drawings, and submissions. The Contractor's Representative shall be responsible for co-ordinating the design, technical information, and data between Sub-Contractors. All calculations, drawings, and information submitted to the Engineer shall be checked by the Contractor's Representative and certified as having been checked before submission.

(d) Contract communication between the Engineer and the Contractor. The Contractor's Representative shall attend all meetings involving the Contractor and the Engineer.

(e) The coordination and programming of the manufacturer's works tests and the submission of test certificates.

(f) The coordination and programming of material delivery.

(g) The coordination and programming of the installation of the materials on the Site, site tests, and takeover trials. The Contractor's Representative, although not necessarily based at the Site, shall be responsible for the various sub-contractors. At the discretion of the Engineer, regular site meetings will be held during which the Contractor's Representative shall give a full account of site progress and programme.

(h) The Contractor's Representative shall also be responsible for producing in advance of the work being undertaken, detailed method statements of any work that involves or affects the performance of existing equipment, processes, or disruption to existing water supplies.

(i) The coordination, preparation, and submission of As-Built Drawings.

(j) Soft copies of all submissions should be in editable form in Word, Excel, PDF, and AutoCAD of later version.

(k) The preparation and coordination of training of Employer's Personnel.
y

(l) The submission of applications for payment.

3.7 Meetings

From time to time, the Engineer will call meetings in his office or at the Contractor's office, or at the project Site, as he deems necessary, to discuss progress and any technical points as required.

The Contractor's Representative or designed person above Contractor's Representative shall attend such meetings.

The Contractor shall prepare and submit to the Engineer a daily activity report summarising the main activities undertaken each day. In addition to design and construction issues, safety and environmental management, and the progress of construction are monitored using an S-Curve Chart.

Apart from the regular project meetings, the Board may conduct any other high level meeting as needed to ensure the progress of the work at site is as per the approved schedule. Contractor and other project stakeholders shall be informed in advance of such meetings.

3.8 Site Photographs

In accordance with the requirements of the Volume 1 of the Conditions of Contract the Contractor shall supply soft copies of photographs and unmounted positive colour prints not less than 250mm x 200mm of such portions of the Works, in progress and completed, as may be directed by the Engineer and specified herein. The soft copies and prints shall not be retouched. The soft copy of each photograph shall be the property of the Employer and shall be delivered to the Engineer with the prints. No prints of these soft copies shall be supplied to any other person without the written permission of the Engineer.

The photographs/videos shall be of the following categories:

- Original/Before construction
- Progress Photographs
- Record Photographs
- Drone Images (Every Month)
- Drone videos (every 3 months)

The above categories shall be properly referenced to the approval of the Engineer, and on the back of each print shall be recorded the date and time of the photograph, the direction in which the camera was facing, an identifying description of the subject, and the reference.

Photographs taken for record purposes as ordered by the Engineer or as specified herein shall be supplied in soft copy and three prints, having the reverse of one superscribed with the signatures of the Contractor and the Engineer (or their authorised representatives) for the purpose of attestation. If required, the Contractor may, at his own expense, have an additional print similarly attested for his retention.

The Contractor shall supply one soft copy and three prints, dated with description of each progress photograph ordered by the Engineer. The Contractor shall supply two additional prints, dated with a description of progress photographs selected by the Engineer for incorporation in albums. The Contractor shall supply two sets of albums, mount the prints, and title the prints and albums, all to the Engineer's approval.

The taking of photographs of the Works by the Contractor for any other purpose, whether for use in India or in any other country, shall not be carried out without written approval from the Engineer.

3.9 A) Setting Out of the Works

The Contractor shall receive the Engineer’s instructions for reference points and elevation points as benchmarks.

The Contractor shall set out the works and carry out the Contractor’s quality control procedures verifying the accuracy and precision of the setting out for each item of the works. The Contractor shall notify the Engineer sufficiently in advance of the setting out to enable the Employer's Representative to observe the accuracy and precision of the laying out. The Engineer's observations shall not relieve the Contractor of responsibility under the Contract for the accuracy and precision of the setting out.

The Engineer shall approve dimensioned drawings, levels, and other information necessary to enable the Contractor to set out the Works, at his own cost. The contractor shall provide all instruments such as theodolite, total station, leveling instruments in good working condition. The contractor shall also provide pegs, ranging rods, long measuring rods, marked meters and decimeters and each meter and decimeter numbered, posts and sight-rails, boning rods, moulds, template etc., together with any reasonable number of labourers that may be required and set out the Works and be responsible for the accuracy of the same. The Contractor shall amend at his own cost and to the satisfaction of the Engineer any error found at any stage which may arise through inaccurate setting out unless such error is based on incorrect data furnished in writing by the Engineer. The Contractor shall protect and preserve all control points and benchmarks used in setting out the Works till the end of the Defects Liability Period unless the Engineer directs early removal. The Contractor should also keep the theodolite and leveling instruments in good working condition throughout the period of construction work on site.

The checking of any setting out or any line or level by the Engineer shall not in any way relieve the Contractor of his responsibility for the correctness thereof.

No separate payment will be made for setting out the Works as required. Unit rates quoted by the Contractor for all items will be deemed to have covered the expenses for such setting out.

B) Details and Data made available by Employer

The Employer has the following data available and used these in the formulation of the bid elements. They are listed below and shall be used only as guidelines. The Employer does not, however, guarantee either the sufficiency or accuracy of the data provided. Contractor shall carry out a fresh survey, investigation, and particular testing/and all other details necessary for proper planning and detailed design. The Contractor will be required to provide full details of the investigations and analysis for approval by the Engineer.

- Site location
- Access Road
- Boundary

3.10 Engineer's Requirements

The Contractor shall provide the following for use by the Engineer at the proposed sites covered under the contract. These items must be maintained by the Contractor in a proper, safe, and clean working condition throughout the construction period.

No separate payment shall be made for the items covered here.

3.10.1 Engineer's Staff Site Office

A separate office/Porta cabin (temporary in nature) with AC Facility & toilet facilities for the sole use of the Engineer, his staff, and Consultant shall be provided by the Contractor at the site. The Contractor shall provide, erect, furnish, clean, maintain, and subsequently transfer the office and associated furniture/items to the Employer after the completion of works. The carpet area of the office shall not be less than 50 Sq. Meter.

The location of the office shall be as directed by the Engineer.

The Engineer's staff office shall be ready in all respects within 60 days after the Contractor takes possession of the site. The Office shall be maintained throughout the construction period with office help staff, power, water, sewerage, and housekeeping. These amenities shall be arranged by the Contractor either with the available resources or from independent sources (e.g. diesel generator sets, borewells, etc.) at his own cost.

The Contractor shall furnish the equipment, furniture, furnishings, and fittings supplied shall be new items of approved make.

The equipment, furniture, and furnishings shall include at porta cabin.

(a) 2 Nos. of 3' x 2' table with single side three drawers
(b) 6 Nos Chairs (approved make) excluding for Computers

(c) 1 No. Drawing Cabinet
(d) Filing cabinets, steel with locks and 2 drawers with suspended filing system
(e) Water supply / Plumbing / Electrical complete/Emergency lighting
(f) Other facilities
- 1 No. of PC and 1 No. of Laptop
- 23" SVGA LCD flat panel colour monitor
- 8 USB 2.0 ports, with at least 2 of these in the front, Broadband Internet with 3MBPS Speed
- Internet keyboard
- Optical Mouse and Mouse Pad (two sets)
- Pre-loaded with the latest licensed Operating System compatible with all Engineering Software.
- Comprehensive Security and Management features such as antivirus, antispyware, and firewall.
- HP Colour LaserJet Printer (suitable for A4/A3 size paper) or equivalent
- Additional software – MS Office and AutoCAD (latest version)
- All the necessary consumables, including paper, CDs, printer cartridges, etc. to be provided throughout the contract period.

(g) Fire Extinguisher – CO_2 type (3 Kg) – 1 No.
(h) First Aid
(i) Domestic water

3.10.2 Vehicles

The Contractor shall purchase and maintain one new Bolero or equivalent (ZLX BS IV, A/C) vehicle for the duration of the contract till taking over certificate is issued, to be kept available at all times for the sole use of the Engineer and his staff, at the contractors own cost. The Contractor shall be solely responsible for the upkeep of the vehicle, including taxes, insurance, licenses, fuel, oils, lubricants, repairs, and maintenance, and shall also provide a competent driver, who shall be familiar with Kannada and Hindi Languages. Vehicle shall be handed over to BWSSB in good working condition upon completion of contract.

3.10.3 Electrical Systems

A. <u>Main Electric Supply (Normal 3 Ph 4 wire supply)</u>

a) Main electrical supply shall be received at single point with IP-55 certified 5 Pin welding socket (63Amp) suitable for 415V 50 Hz for distribution of power supply to various appliances.

b) One main incomer distribution board (3 Ph, 4 wire) shall be provided in each cabin with 1 No. RCCB (30 mA sensitivity) along with 63Amps 4 pole MCB and individual MCBs for light, fans and AC. All MCBs shall be housed in metal enclosure.

c) All wiring shall be done with FRLS multistrand PVC insulated copper wire and PVC conduit of concealed type for wiring.

d) The wiring of Air Conditioner (AC) shall be 6 Sq.mm and for lighting/fans shall be 4 Sq.mm.

B. Electrical Fittings

a) LED Battens / Tubes – 4 Nos.
b) 5A Switch & Sockets – 3 Nos.
c) 15A Switch & Sockets – 3 Nos.
d) Emergency LED/CFL Lights with inbuilt battery (2 hrs battery backup) – 2 Nos.
e) Ceiling mounted Fans swing type (12") – 2 Nos.
f) Air-conditioner points with RCCB as per requirement of electricity norms.
g) Split AC of minimum 1.5T with arrangement of condenser unit at one corner inside cabin but open able from outside with locking arrangement.
h) Earthing Arrangements for Panels, DBs, lighting, sockets etc.
i) Projector for meetings.
j) UPS for 1 hour power backup.

3.10.4 Assistance to the Engineer

The Contractor shall provide all necessary assistance to the Engineer and his staff in carrying out their duties of checking, inspecting, and measuring the Works. The Contractor shall provide, at no additional cost, chainmen, staff men, office attendants, and labourers as may be needed from time to time by the Engineer.

The Contractor shall provide the Engineer, his staff, consultants, and their staff, as well as visitors, with protective clothing, safety helmets, and rubber boots of suitable sizes, hand lamps, and other necessary items as may be reasonably required by them. These articles shall remain the property of the Contractor. No extra payment shall be made on this account.

3.10.5 Instruments to be provided

The Contractor shall provide at his own cost for the exclusive use of the staff of the Engineer all survey equipment and measuring instruments of approved make and of every kind necessary for the execution of the Works, including:

(a) Battery operated latest automatic total station with full setup and software/ One 360-degree circle optic theodolite, accurate to one second, complete with carrying case and sliding leg tripod, with an operator shall be in use by the client for the entire construction period.

(b) Two auto levels, tripods with carrying case.

(c) Two levelling staffs, 4.5 m long, each in 3 sections and with attached bubbles, graduated in metres, tenths and hundredths of a metre.

(d) Two surveyor's steel bands, one 100 m long and approximately 20 mm wide, and the other at least 30 m long and approximately 12 mm wide, each fully divided, complete with tape thermometers and tension handles, and wound on an open plastic cross.

(e) An adequate number of ranging rods, steel and linen tapes, string lines, pegs, lines, spirit levels, survey umbrellas, lights, batteries, stores, and tools.

The instruments mentioned above shall be for exclusive use of the Engineer and shall remain in the custody of the Engineer till the Works are completed.

The Contractor shall be solely responsible for all such instruments and equipment and shall ensure that they are in good condition at all times and shall make good any loss or damage howsoever caused. No extra payment shall be made on this account.

3.11 Site Labour and Supervision

The Contractor shall provide all skilled and unskilled labour required, as well as all necessary tools and equipment, to erect, test, and commission the Works within the period agreed upon in the programme.

The Contractor shall not remove any supervisory staff or skilled labour from the Site without the Engineer's prior approval.

3.12 Sub-letting

The Contractor shall not sublet the whole of the Works. Where any design or manufacture is sublet, the Contractor shall not be relieved of his obligation under the Contract. The Contractor shall be responsible for the acts, defaults, and neglect of any Sub-Contractor, as if they were their own.

Where the Engineer has consented to the supply of Sewer Network or execution of work by manufacturers or sub-contractors proposed by the Contractor, such manufacturers or sub-contractors shall not be changed without the prior approval in writing of the Engineer.

A copy of every sub-order shall be sent to the Engineer at the time each order is placed clearly marked with the title of the Contract and the Contract number.

3.13 Temporary Works

At least 14 days before commencing any portion of the Works, the Contractor shall submit to the Engineer for approval comprehensive drawings and calculations for all Temporary Works that the Contractor proposes for the construction of that part of the Works.

Notwithstanding approval by the Engineer of any design for the Temporary Works, the Contractor shall be entirely responsible for their safety, efficiency, security, and maintenance and for all obligations and risks in regard to such Temporary Works specified or implied in the Contract.

3.14 Languages

All drawings, instructions, signs, notices, name-plates, etc. for use in the design, construction, operation, and maintenance of the Works shall be in English.

All site sign boards and warning signs shall be in Kannada, Hindi and English Languages.

3.15 Drawings and Information to be provided

3.15.1 General

The drawings that will be prepared and issued for this Contract shall be classified as follows, and where relevant, shall be to a scale which is suitable for the representation of those details illustrated.

The term Drawing shall be deemed to include all drawings, schedules, lists, software documentation, descriptive text, and calculations necessary for the design, construction, operation, and maintenance of the Works and referred to in this clause.

Drawings and all other submittals required during the bidding stage and after the award of the contract shall be submitted in editable electronic softcopy format on CD(s) or DVD(s) as well as in hardcopy paper format. The Contractor shall submit documents in soft copies and eight (8) sets of hard copies to the client for approval.

The softcopy format for various items shall be as follows:

- Drawings: AutoCAD version 2024
- Text Documents: Latest Version of Microsoft Word including Microsoft Project
- Spreadsheets, Hydraulic design/capacity/power calculations, tables, technical schedules, prices schedules, and other numerical data: Latest version of Microsoft Excel
- All other required information not included in the above: Adobe Portable Document Format (PDF) version 7.x

The hardcopy format/sizes for various items shall be as follows:

- Drawings: Standard A1 size paper. The scale for each drawing shall be selected such that the information is presented without any clutter or ambiguity and is clearly and easily legible without the use of magnifying aids other than a reader's normal eyeglasses.
- All other information: Standard A4 or A3 paper size, except for any pre-printed standard information such as brochures or catalogue information, which may be submitted in the original size and format.

3.15.2 Drawing Format and Numbering

All drawings shall be prepared using an identical title block format. This shall be approved by the Engineer and shall identify the project, drawing title, the Employer, the Contractor, Sub-contractor, if applicable, and the Engineer.

A formalised drawing numbering system shall be adopted with digits of each number, referencing location, revision, drawing type and size. The Engineer shall approve the numbering format and allocation of drawing number blocks.

The Contractor shall provide a sequential numbering system for all Construction Documents. The drawing number shall not be repeated or duplicated.

All drawings shall be submitted to a formalised checking procedure before submission. Drawings not so checked will not be approved.

3.15.3 Pre-contract Drawings

The Pre-contract Drawings are those issued to Bidders either with the Bidding Documents to illustrate and clarify the Works described in the Employer's Requirements or later during the bidding period as part of an Addendum to the Contract Documents.

Such drawings shall be deemed to have been issued for the guidance of Bidders and shall, to execute the Works, be superseded by the Construction Documents.

3.15.4 Bid Drawings and Details

The Bid Drawings are those furnished by a Bidder with his Bid to illustrate and clarify his proposals.

The bidder shall be responsible for including all necessary drawings and information for any works that may be required to fully and completely define or clarify the design, regardless of whether such drawings, information, or works are explicitly listed below or elsewhere in these bid documents.

The bid drawings and other technical documents shall be submitted in soft copy format on CD(s) or DVD(s) or pen drive as well as in hardcopy paper format.

3.16 Notice of Operations

The Contractor shall provide the Engineer with full and complete written notice of all important operations sufficiently in advance to enable the Engineer to make necessary arrangements for inspection and any other purpose. The Contractor shall not start any important operation without the written approval of the Engineer.

3.17 Protection of Existing Installations

The Contractor shall submit a written application to the Engineer at least 28 days prior to commencing any work that involves interference with existing structures, equipment, or other facilities. The Contractor shall not execute such work until he has received permission to proceed, in writing, from the Engineer.

The Contractor shall ensure that no earth, debris, or rock is deposited on public or private roads or rights of way as a result of the Works, and all vehicles leaving the Site shall be cleaned accordingly.

3.18 Protection of Existing Public and Private Services

The Contractor shall notify all public authorities, utility companies, and private owners of proposed works that will affect them at least two weeks before commencing the works.

The Contractor shall adequately protect, uphold, maintain, and prevent damage to all services and shall not interfere with their operation without the prior consent of the public authorities, utility companies, private owners, or the Engineer as appropriate.

If any damage to services results from the execution of the Works, the Contractor shall immediately:

(a) Notify the Engineer and appropriate public authority, utility company, or private owner.

(b) Make arrangements for the damage to be made good without delay, to the satisfaction of the relevant public authorities, utility company, or private owner, as appropriate. The Contractor shall be liable for all costs for making good such damage.

The Engineer may issue instructions or make other such arrangements as he deems necessary to repair rapidly any essential services damaged during the execution of the Contract. Such arrangements shall not affect any liability to pay for making good the damage.

3.19 Reinstatement and Compensation for Damage to Persons or Property

The Contractor shall reinstate all properties, whether public or private that are damaged in consequence of the construction and maintenance of the Works to a condition as specified and at least equal to that which existed before their first entry.

If in the opinion of the Engineer the Contractor shall have failed to take reasonable and prompt action to discharge his obligations in the matter of reinstatement, the Engineer will inform the Contractor in writing of his opinion, in which circumstances the Employer reserves the right to employ others to do the necessary work of reinstatement and to deduct the cost thereof as certified by the Engineer from any money due or which shall become due from the Employer to the Contractor.

The Contractor shall refer to the Employer without delay all claims, which may be considered to fall within the exceptions listed in the Conditions of Contract.

3.20 Packing and Protection

Before any material is dispatched from a manufacturer's factory, it shall be adequately protected and packed to ensure that it will arrive on the Site in an undamaged condition. The methods employed for protection and packing must be suitable for withstanding the conditions which may be experienced during shipment, delivery to the Site, and prolonged periods of storage in the open, whether the items are shipped in packing cases, crates, or only partially protected according to their nature.

Bright parts and bearing surfaces shall be protected from corrosion by applying a rust preventive lacquer, high-melting-point grease, or similar temporary protection. A sufficient quantity of solvent shall be supplied with the materials to enable the coating to be removed on-site.

All machined flanges and other mating surfaces shall be protected by means of wood templates. The bolts for securing these templates shall not be reused in the final installation.

All items of Sewer Network shall be clearly marked for identification against the packing list, which shall be placed in a waterproof envelope inside every packing case or crate.

Every packing case and crate shall be indelibly marked to show its weight, serial number, top and bottom, shipping marks and handling instructions or sling marks.

Electrical items shall be enclosed in sealed airtight packages with dehydrating material, before being placed in packing cases on shock-absorbent material and secured by means of battens.

3.21 Quality Assurance

3.21.1 Policy

In accordance with Clause 4.9 of the Conditions of the Contract, the Contractor shall apply the formal requirements of Quality Assurance to the design, supply, construction, and maintenance of the Works. This shall be achieved through the implementation of a Quality System compliant with the requirements of BS 5750 or an equivalent International Standard.
A positive commitment to Quality Assurance shall be expressed in a formal policy statement included in the Contractor's Quality Manual.

3.21.2 Objectives

It shall be the stated aim of the Contractor to achieve and demonstrate the achievement of quality as expressed by `due care and diligence' of the design, supply, construction and maintenance of the Works as defined by the Employer's Requirements.
The criteria to define `due care and diligence' shall be explained in the Contractor's Quality Plan and shall embody all of the design, supply, construction, and maintenance requirements of the Works.

3.21.3 Quality System

The Quality System shall be fully integrated for all works.

This system will be defined by the organisational structure, responsibilities, activities, resources, and events that, together, demonstrate the Contractor's capability to meet the stated quality requirements.

The Contractor shall ensure that all Sub-Contractors and sub-consultants establish quality systems and supply the Employer with such evidence as is necessary to demonstrate the effective implementation of a quality system in each Sub-Contractor or sub-consultant organisation.

The Quality System of the Contractor, their Sub-Contractor, and sub-consultants will be subject to periodic audits undertaken by the Engineer. The Engineer will give two weeks' notice of such audits that will involve a full assessment of the performance and efficiency of the Quality System and will include review of the feedback and records derived from the Contractor's monitoring and internal reviews.

On a day-to-day basis the Contractor shall afford reasonable availability of staff and documentation for the Engineer to assess the implementation of the Quality System. The Contractor shall ensure that all relevant personnel and documentation are available for such audits.

3.21.4 Quality Plan

The implementation of the Quality System shall be through the establishment of a comprehensive Quality Plan issued to and approved by the Engineer.

The documented procedures shall include, but not be limited to:

- Management Procedures.
- Design.
- Supply/Procurement.
- Construction.
- Putting to work/Commissioning/Reliability Trial/Performance Test, witnessing the test and review.
- Operator Training and Maintenance.
- Interface Control.
- Quality Performance, Monitoring and Review.

There shall be procedures to control transmission of information across all interfaces both internally (that is, within the Contractor's Quality System) and externally. Those of the latter shall include all Statutory Bodies, Authorities and the Engineer.

Formal assessment of any non-compliance with the Quality Plan shall be achieved through periodic reviews undertaken by a team appointed by the Contractor. All deficiencies shall be recorded and appropriate corrective measures shall be assessed, within an appropriate timescale, through subsequent formal reviews undertaken by the Contractor.

3.21.5 Quality Feedback

The system shall include for the reporting back, recording and incorporation into the system of deficiencies and remedial measures to correct them noted during the control of the project.

3.22 Environmental Protection

The Contractor shall minimize, as far as is practically possible, the effects of all his and his Subcontractor's activities upon the environment and shall implement and monitor measures to prevent:

(a) Contamination of surfaces, ground, groundwater, surface water, and rivers.
(b) Emissions to air, including smells, gases, smoke, and dust.
(c) Unsanitary or unsafe storage or discharge to drain, sewer and surface waters.
(d) Unsanitary or unsafe storage or disposal of solid waste.
(e) Noise.
(f) Visual intrusion, and
(g) Excessive energy and water consumption.

These requirements shall be met through the constant and careful attention of the Contractor's management to all Site and off-site activities, and by instructing all staff and labour in these matters.

The Contractor shall appoint an Environmental Control Manager for the Works, who shall be responsible for preparing an Environmental Management Plan and ensuring its implementation by the Contractor after obtaining the Engineer's approval.

Implementation shall include monitoring and reporting on the results of the above measures. Monitoring reports shall be submitted in writing every month as part of the monthly report referred to above. The report shall include a listing and summary of daily monitoring results on all aspects listed above.

All potentially affected areas of the Site, other areas used for or affected by the works, and all adjacent or affected waterways shall be monitored and, where instructed by the Engineer, tested.

The Environmental Management Plan (EMP) (Also refer part 18, of Volume 2, section 7) shall identify the potential environmental impacts from the various construction and operations and maintenance activities to be undertaken in the Contract and set out in detail the approach he will adopt in mitigating these environmental impacts to ensure that the residual impacts are minor and confined to a short period.

The EMP shall consider, but not be limited to, the following:

- The methods of materials delivery, storage, usage, and disposal; equipment usage; and site activities to ensure they have minimal impact on the environment.
- Only environmentally safe products and practices shall be adopted in performing his works and
- The Contractor shall comply with all applicable statutes regarding environmental effects.

The EMP shall provide separate descriptions of its proposals for minimizing any adverse environmental impacts/effects during the construction phase and the subsequent operations and maintenance phase.

The EMP shall be provided in draft form within 28 days from the Notice to Commence, and shall be updated from time to time by the Contractor as agreed or required by the Engineer to ensure the objectives of environmental protection are fully met.

3.23 Safety

The Contractor shall prepare a Safety Plan and submit it to the Engineer for approval within 28 days of receiving the Notice to Proceed.

The Safety Plan shall be followed at all times by the Contractor and shall contain adequate control measures, with the following the relevant protection of property and local laws and regulations as well as internationally accepted good practice, for the prevention of accidents, fires, and public nuisance.

The Safety Plan shall be implemented properly and diligently throughout the execution of the Works and during the operations and maintenance period.

The Contractor's Safety Plan shall make safety provisions for, among other things:

(a) Deep excavations and collapsing sides in trench excavations.
(b) Scaffolds and overhead working.
(c) Working in confined spaces.
(d) Working in water.
(e) Contractor's equipment, especially cranes, heavy vehicles, etc.
(f) Hand-held power tools.
(g) Electrical equipment, power connection.
(h) Hazardous chemicals, gases, and fuels.
(i) The use of protective clothing and
(j) The provision of first aid facilities.

On-Site Patrol

- The Safety Manager patrols every day (preparation of report & announcement in morning meeting)
- Surprise inspection by the Engineer
- Regular safety exercise
- Morning meeting every day

The Contractor shall at all times in the conduct of his work and that of his Subcontractors adhere to the established rules and regulations concerning all safety matters at Site such as the recommendations contained in the "Manual of Accident Prevention in Construction", published by the Associated General Contractors of America, Inc., or other Internationally recognized recommendations to the extent that such provisions do not conflict with the applicable laws. This is especially important wherever it is necessary to enable the free passage of the public through the Site.

The Safety Plan shall be developed to ensure zero fatal accidents and zero hazardous incidents or occurrences in all construction work. The Safety Plan shall include descriptions of the company's standard policies and procedures regarding its site organization and procedures, methods and frequency

of conducting safety audits at the Site(s), record keeping and reporting, providing safety training for its personnel (including subcontractors), issue and mandatory use of safety equipment, and details of the qualifications and experience of the Bidder's proposed safety officers to be deployed at the Site(s). The Contractor shall provide separate descriptions in its Safety Plan covering the construction phase and the subsequent operations and maintenance phase.

- The Contractor shall appoint a full-time Expert/ Health and Safety Engineer/Manager (Accident Prevention Officer) having the required qualifications and experience in this field, who shall be responsible for implementing the Safety Plan. He should have the authority to issue instructions to the Contractor's personnel regarding protection measures to prevent accidents.
- The Contractor shall provide the public with adequate information on all risks associated with the construction works. If the general public sustains any bodily injury or death, the Contractor shall be responsible for providing all necessary medical care and compensation.

The Contractor shall ensure that his staff, labour, and Subcontractors are all fully trained in and aware of good and safe working practices.

The Contractor shall ensure that all precautions are taken to safeguard the general public and construction/operating staff from any danger.

- During construction, the Contractor shall erect, maintain, and subsequently remove sufficient barricades, guards, lighting, sheeting, shoring, temporary sidewalks and bridges, danger signals, as well as temporary covering of potential accident areas, as approved by the Employer. All temporary and partially completed works shall be protected by way of barriers, lights, notices and the like. All excavations and the like are to be protected by barriers at all times and adequately illuminated at night. An adequate number of Life buoys are to be provided near water retaining structures with a depth of more than 1.2m during the construction and Operation & Maintenance stages.

- All open excavations along pipeline shall be protected sufficiently to keep out livestock, ensure the safety of workmen and members of the public, and be in accordance with the directives of the police and other local regulations.
- The Contractor shall be responsible for ensuring that all persons working in the vicinity of power lines are aware of the relatively large distance that high-voltage electricity can "short" to earth when cranes or other large masses of steel are present in the vicinity of power lines.
- Where work is to be carried out in the proximity of buildings, bridges, tanks or other structures, the Contractor shall take all necessary precautions, including shoring and strutting, where necessary, to ensure the safety of the structures that are at risk.
- The Contractor shall be responsible for all damages or injury which may be caused on any property by trespass by the Contractor's or his Subcontractor's employees in the course of their employment, whether the said trespass was committed with or without the consent or knowledge of the Contractor.

Warning and diversion signs concerning roadwork shall be suitably placed to give motorists ample warning. During the movement of heavy vehicles across roads or onto roads, men, bearing red flags, shall be in attendance to warn other road users and to generally control traffic in a safe manner.

The Safety Plan shall also consider requirements for warning and protection for other risks including overhead and underground cables, pipes or obstructions, or voids, openings, pits and trenches. The Contractor shall ensure that all appropriate measures are implemented.

1. Suitable scaffolds should be provided for workmen for all works that cannot safely be done from the ground, or from solid construction, except such short-period work as can be done safely from ladders. When a ladder is used, an extra mazdoor shall be engaged for holding the ladder. If the ladder is used for carrying materials as well, suitable footholds and hand-holds shall be provided on the ladder, and the ladder shall be given an inclination not steeper than ¼ to 1 (¼ horizontal and 1 vertical).

2. Scaffolding of staging more than 3.6 m above the ground or floor, swung or suspended from an overhead support or erected with stationary support shall have a guard rail properly attached or bolted, braced and otherwise secured at least 90 cm. high above the floor, or platform of such scaffolding or staging and extending along the entire length of the outside and ends thereof with only such opening as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure.

3. Working platforms, gangways and stairways should be so constructed that they should not sag unduly or unequally, and if the height of the platform or the gangway or the stairway is more than 3.6 m above ground level or floor level, they should be closely boarded; should have adequate width and should be suitably fastened as described in (2) above.

4. Every opening in the floor of a building or in a working platform shall be provided with suitable means to prevent the fall of a person or materials by providing suitable fencing or railing whose minimum height shall be 90 cm.

5. Safe means of access shall be provided to all working platforms and other working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9 m. in length, while the width between side rails in a rung ladder shall in no case be less than 29 cm for a ladder up to and including 3 m. in length. For longer ladders, this width should be increased by at least 6 mm for each additional 30 cm of length. Uniform step spacing of not more than 30 cm shall be kept. Adequate precautions shall be taken to prevent danger from electrical equipment. No materials on any of the sites or work shall be so stacked or placed as to cause danger or inconvenience to any person or the public. The contractor shall provide all necessary fencing and lights to protect the public from accidents. The Contractor shall be bound to bear the expenses of defense of every suit, action or other proceedings at law that may be brought by any person for injury sustained owing to neglect of the above precautions and to pay any damages and cost which may be awarded in any such suit, action or proceedings to any such person.

6. Excavation and Trenching - All trenches 1.2 m. or more in depth shall at all times be supplied with at least one ladder for each 30 m. in length or fraction thereof. The ladder shall extend from the bottom of the trench to at least 90 cm above the surface of the ground. The sides of the trenches, which are 1.5 m. or more in depth, shall be stepped back to give a suitable slope or securely held by timber bracing, so as to avoid the danger of sides collapsing. The excavated materials shall not be placed within 1.5 m of the edges of the trench or half of the depth of the trench, whichever is greater. Cutting shall be done from top to bottom. Under no circumstances shall undermining or undercutting be done.

7. Demolition - Before any demolition work is commenced, and also during the progress of the Work,

i) All roads and open areas adjacent to the work site shall either be closed or suitably protected.

ii) No electric cable or apparatus which is liable to be a source of danger or cable or apparatus used by the operator shall remain electrically charged.

iii) All practical steps shall be taken to prevent danger to persons employed from risk of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render it unsafe.

8. All necessary personal safety equipment deemed adequate by the Employer should be kept available for use by the person employed on the site and maintained in a condition suitable for immediate use. The contractor should take adequate steps to ensure the proper use of equipment by those concerned.

The following safety equipment shall invariably be provided.

i) Workers employed on mixing asphalt materials, cement, and lime mortars shall be provided with protective footwear and protective goggles.

ii) Those engaged in whitewashing and mixing or stacking of cement bags or any material that is injurious to the eyes shall be provided with protective goggles and nose masks.

iii) Those engaged in welding works shall be-provided with welder's protective eye Shields, nose mask & gloves.

iv) The stone breaker shall be provided with protective goggles and clothing and seated at sufficiently safe intervals.

v) When workers are employed in sewers and manholes, which are in active use, the contractors shall ensure that the manhole covers are opened and ventilated at least for an hour before the workers are allowed to get into the manholes, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident to the public, in addition, the contractor shall ensure that the following safety measures are adhered to:

a) Entry for workers into the line shall not be allowed except under the supervision of the Engineer.

b) At least 5 to 6 manholes upstream and downstream should be kept open for at least 2 to 3 hours before any man is allowed to enter the manhole for working inside.

c) Before entry presence of Toxic gases should be tested by inserting wet lead acetate paper which changes colour in the presence of such gases and gives indication of their presence.

d) Presence of Oxygen should be verified by lowering a detector lamp into the manhole. In case, no Oxygen is found inside the sewer line, workers should be sent only with Oxygen kit and self-contained breathing apparatus (SCBA).

e) Double lanyard safety harness with shock absorber and rope should be provided to the workers. While working inside the manholes such rope should be handled by two men standing outside with pulley system to enable him to be pulled out during emergency conditions.

f) The area should be barricaded or cordoned off by suitable means to avoid mishaps of any kind. Proper warning signs should be displayed for the safety of the public whenever cleaning works are undertaken during night or day.

g) No smoking or open flames shall be allowed near the blocked manhole being cleaned.

h) The malba (solid waste) obtained on account of cleaning of blocked manholes and sewer lines should be immediately removed to avoid accidents on account of slippery nature of the malba.

i) Workers should not be allowed to work inside the manhole continuously. He should be given rest intermittently. The Engineer may decide the time up to which a worker may be allowed to work continuously inside the manhole.

j) Self-contained breathing apparatus (SCBA) and first aid should always be present at site for use in any emergency.

k) Air-blowers should be used for flow of fresh air through the manholes. Whenever called for portable air blowers are recommended for ventilating the manholes. The Motors for these shall be vapour proof and of totally enclosed type. Non sparking gas engines also could be used but they should be placed at least 2 meters away from the opening and on the leeward side protected from wind so that they will not be a source of friction on any inflammable gas that might be present.

l) The workers engaged for cleaning the manholes/sewers should be properly trained in "Confined Space" before allowing working in the manhole.

m) The workers shall be provided with Gumboots or non-sparking shoes bump helmets and gloves non sparking tools safety lights and gas masks and portable air blowers (when necessary). They must be supplied with barrier cream for anointing the limbs before working inside the sewer lines.

n) Workmen descending a manhole shall try each ladder stop or rung careful before putting his full weight on it to guard against insecure fastening due to corrosion of the rung fixed to manhole well.

o) If a man has received a physical injury, he should be brought out of the sewer immediately and adequate medical aid should be provided to him.

p) The extent to which these precautions are to be taken depend on individual situation but the decision of the Engineer regarding the steps to be taken in this regard in an individual case will be final.

vi) Contractor shall be fully responsible in the event of death of employee/workmen during the execution of the work and liable to pay adequate compensation to the dependants of employee/workmen as per law. On his/their failure, if the Board is made to pay compensation the same shall be recovered by the Board from the contractor out of the amount due to the contractor or by appropriate legal action. If death of any employee occurs during execution of work due to negligence of contractor, the contract may be liable for termination. The Board will be entitled to claim exemplary damages from the contractor in case of death of any workman/employees of the contractor in any of the BWSSB works as it damage the reputation of the Board.

vii) The Contractor shall not employ men and women below the age of 18 years on the work of painting with products containing lead in any form. Wherever men above the

age of 18 are employed on the work of lead painting, the following precaution should be taken:-

a) No paint containing lead or lead products shall be used except in the form of paste or readymade paint.

b) Suitable face masks should be supplied for use by the workers when paint is applied in the form of spray or a surface having lead paint is dry rubbed and scraped.

c) Overalls shall be supplied by the contractors to the workmen and adequate facilities shall be provided to enable the working painters to wash during and on the cessation of work

d) White lead, sulphate of lead or product containing these pigments, shall not be used in painting operation except in the form of pastes or paint ready for use.

i) Measures shall be taken, wherever required in order to prevent danger arising from the application of paint in the form of spray.

ii) Measures shall be taken, wherever practicable, to prevent danger arising out of from dust caused by dry rubbing down and scraping.

iii) Adequate facilities shall be provided to enable working painters to wash during and on cessation of work.

iv) Overalls shall be worn by working painters throughout the entire working period.

v) Suitable arrangement shall be made to prevent clothing put off during working hours from being spoiled by painting materials.

vi) Cases of lead poisoning and suspected lead poisoning shall be notified and shall be subsequently verified by doctor's appointed by the competent authority of BWSSB.

vii) BWSSB may require, when necessary, medical examination of workers, including measuring blood lead levels.

viii) Instructions regarding special hygienic precautions to be taken during painting.

9. When the work is done near any place where there is a risk of drowning, all necessary equipment should be provided and kept ready for use. All necessary steps should be taken for the prompt rescue of any person in danger, and adequate provision should be made for prompt first aid treatment of all injuries likely to be obtained during the work.

10. Use of hoisting machines and tackle, including their attachments, anchorage, and supports, shall conform to the following standards or conditions:

i. These shall be of good mechanical construction, sound materials, and adequate strength and free from patent defects and shall be kept repaired and in good working order.

ii. Every rope used in hoisting or lowering materials or as a means of suspension shall be of durable quality and adequate strength, and free from patent defects.

iii. Every crane driver or hoisting appliance operator shall be properly qualified, and no person under the age of 21 years should be in charge of any hoisting machine, including any scaffolding winch, or give signals to the operator.

iv. In case of every hoisting machine and of every chain ring hook, shackle swivel and pulley block used in hoisting or as means of suspension, the safe working load shall be ascertained by adequate means. Every hoisting machine referred to above shall be plainly marked with the safe working load. In case of a hoisting machine having a variable safe working load each safe working load and the condition under which it is applicable shall be clearly indicated. No part of any machine or load. Gear referred to in this paragraph shall be loaded beyond its safe working load, except for testing.

v. The Contractors shall notify the safe working load of the machine to the Employer-in-charge whenever they bring any machinery to the site of work and get it verified by the Electrical Employer concerned.

11. Motors, gearing, transmission, electric wiring, and other hazardous parts of hoisting appliances should be equipped with effective safeguards. Hoisting appliances should be provided with such means as will reduce to the minimum the risk of accidental descent of the load. Adequate precautions should be taken to minimize the risk of any part of a suspended load becoming accidentally displaced. When workers are employed on electrical installations that are already energized, they should use insulating mats and wear appropriate protective clothing. Gloves, sleeves, and boots, as necessary, should be provided. The worker should not wear any rings, watches, or carry keys or other materials, which are good conductors of electricity.

    All scaffolds, ladders, and other safety devices mentioned or described herein shall be maintained in a safe condition, and no scaffold, ladder, or equipment shall be altered or removed while it is in use. Adequate washing facilities should be provided at or near the workplace.

12. These safety provisions should be brought to the notice of all concerned by display on a notice board at a prominent place at the workplace. The person responsible for compliance of the safety code shall be named therein by the contractor.

13. To ensure effective enforcement of the rules and regulations relating to safety precautions, the arrangements made by the contractor shall be open to inspection by the Labour Officer or Employer-in-Charge of the department or their representatives.

14. Notwithstanding the above Clauses from (1) to (13) there is nothing in these to exempt the contractor from the operations of any other Act or Rule in force In the Republic of India.

3.26.1 Additional Safety Guidelines

Following guidelines/instructions should be adhered to in the true spirit:-

1. An inspection register should be placed at the sewerage network, where all inspecting officers can record their observations. No unauthorized entry should be allowed.

2. A caution board showing the restricted entry area and the names of components and the moving mechanical parts should be displayed.

3. The entry to all BWSSB infrastructures should be restricted to the person /persons authorized by BWSSB or having I.D cards issued by the chief security officer.

4. Just after entering the premises do’s and don’ts should be displayed at prominent places in all three languages.

5. Even authorized visitors should be provided with proper uniform /visitor badges, helmets, and relevant safety gear and given instructions before showing such infrastructure.

No person below 18 years age should be allowed on the premises where chances of emission of toxic gases are extensive.

3.26.2 National Human Rights Commission (NHRC) Guidelines

NHRC issued guidelines on the safety code for the operation/maintenance of the sewerage system, which have to be strictly followed during the execution of work. Directions given by the Hon'ble Supreme Court in the matter of the National Campaign for Dignity and the Rights of Sewerage and Allied Workers.

1. The medical examination and medical treatment will be given free of charge to sewer workers, and the treatment will continue for all such workers found to be suffering from an occupational disease, ailment, or accident until the workman is cured or until death.
2. The services of the sewer workers are not to be terminated, either by the respondents or the contractors engaged by them, during the period of illness, and they shall be treated as if on duty and will be paid their wages.
3. The respondents shall pay on the death of any worker, including any contract worker, an immediate ex-gratia solatium of one lakh with liberty to recover the same from contractors, if permissible in law.
4. The respondents shall pay/ensure payment of all statutory dues such as Provident Fund, Gratuity, and Bonus to all the sewer workers, including contract workers, as applicable in law.
5. The respondents shall provide, as soon as possible, modern protective equipment to all the sewer workers in consultation with the petitioner organization.
6. The respondents shall provide soap and oil to all the workmen according to the present quota, but on a monthly basis and not at the end of the year.
7. The respondents shall provide all workmen including contract workmen with an accident-card-cum-wage-slip.

3.26.3 Protection of Overhead and Underground Services

- The Contractor will be held responsible for any damage to known services (i.e., overhead services that are visible within the Site and underground services shown on the drawings) and shall take all necessary measures to protect them. All work or protective measures shall be subject to the approval of the Employer. In the event of a service being damaged, he shall inform the Employer and the authority concerned. The Contractor shall not repair any such service unless instructed to do so.
- Contractor will map the underground utilities. Where no underground services are shown on the drawings or scheduled but the possibility of their presence can reasonably be inferred, the Contractor shall, in collaboration with the Employer, ascertain whether any such services exist within the relevant section of the Site. The Contractor shall conduct such an investigation well in advance of the commencement of construction work in the said section and submit a report in a timely manner to enable the Employer to take necessary actions.
- In main roads and junctions, irrespective of utility services indicated in the drawing, the Contractor needs to take proper care prior to commencement of Construction activities so as to ensure minimum disruption to the services. This may require even making a cross-sectional trial pit to determine the exact alignments of different utilities.
- Taking care of other utility services infrastructure during the execution of the works is the responsibility of the Contractor. Nothing in the Contract should relieve the Contractor from their responsibility towards the safety of other utility services infrastructure during project execution. The Contractor's Construction program should include such activities, and no extra claim towards time of completion, and for

consideration, no extra claim regarding time of completion or cost in this regard shall be entertained.

- As soon as any underground service not shown on the drawings is discovered, it shall be deemed to be a known service and the Contractor will be held responsible for any subsequent damage to it.
- Where the authority concerned elects to carry out on its own account any alterations or protective measures, the Contractor shall co-operate with and allow such authority reasonable access and sufficient space and time to carry out the required work.

The Safety Plan shall include a policy statement signed by the CEO or equivalent authority of the Organization declaring that safety and loss prevention shall be given the highest practicable priority in all aspects of the Contract. The Safety Plan shall be updated as necessary to cover the activities to be undertaken for operations and maintenance.

End of Part 3

PART 4

GENERAL WORKMANSHIP AND MATERIAL REQUIREMENTS

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PART 4

GENERAL WORKMANSHIP AND MATERIAL REQUIREMENTS

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PART 4

GENERAL WORKMANSHIP AND MATERIAL REQUIREMENTS

4.1 Introduction

This part of the Employer's Requirements outlines the standards for materials, workmanship, and design that the Contractor must use for the Works. Reference to any specific material or equipment does not necessarily imply that such material or equipment is to be included in the Works.

All plants used for the works shall, unless otherwise specified, comply with the provisions of this part.

The names of the manufacturers of materials and equipment proposed for incorporation in the Works together with performance, capacities, certified test reports and other significant information pertaining to the same, shall be furnished when requested for consideration by the Engineer, who shall have power to reject any parts which in his opinion are unsatisfactory or not in compliance with the specifications and such parts shall be replaced by the Contractor at no extra cost to the Employer.

4.2 Compliance with Standards

The British Standard specifications shall refer to the latest issue or revision of those standards as issued by the British Standards Institution of 2 Park Street, London W1, and the Indian Standard Specifications as issued by the Bureau of Indian Standards. Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110 001 and ASTM standards as issued by the American Society for Testing and Materials, 1916, Race Street, Philadelphia, PA, 19103, U.S.A and ANSI standards as issued by the American National Institute, 1430, Broadway, New York, NY 10018, U.S.A. Equipment conforming to other national or international standards shall be at least equivalent to those specified and shall be subject to approval by the Engineer. The Contractor shall provide full details of the difference.

Where the design or choice of materials of plants is affected by the Factory Acts, then the materials and plant supplied shall comply with all relevant sections of those Acts even though no particular reference may be made in this specification.

The Contractor shall obtain at least one copy of each IS, BS, ANSI, ASTM, or other approved standard or reference material referred to in the Specification, as well as a copy of all other standards applicable to the materials being supplied to, or workmanship executed on, the works. These standards and reference material shall be supplied to the Employer's Representative within 45 days of the commencement date and will be available to the Contractor at all reasonable times.

4.3 Materials General

All materials incorporated into the Works shall be the most suitable for the duty concerned and shall be new, of first-class commercial quality, free from imperfections, and selected for long life and minimal maintenance.

All submerged moving parts of the works, including the pins and spindles, as well as the faces in contact with them (such as water, sludge, or sewage), shall be made of corrosion-resistant metals. All parts in direct contact with various chemicals shall be completely resistant to corrosion or abrasion by these chemicals and shall also maintain their properties without aging due to the passage of time,

exposure to light, or any other cause. Where mild steel is specified for submerged parts, the metal shall be protected by polyurethane coating.

Where “stainless steel" is specified or used, it shall have resistance to atmospheric corrosion not less than that provided by Stainless Steel ASTM A 276 Gr. 410 for forgings and BS EN 10293:2015, Grade 410-C-21 for castings. Particular attention shall be given to the prevention of seizure by fretting when two corrosion-resistant metals are in contact, by selecting materials with suitable relative hardness and surface finish, and by applying lubricants. Where bronze is specified or used, it shall be zinc-free, to BS EN 1982:2017.

Particular attention shall be paid to the prevention of corrosion due to the close proximity of dissimilar metals. Where it is necessary to use dissimilar metals in contact, these shall be selected so that the bimetallic corrosion is as low as possible. The publication by H.M. Stationery Office (in the U.K.), entitled “Corrosion and Its Prevention at Bimetallic Contacts," shall be used as a guide.

4.4 Workmanship General

Workmanship and general finish shall be of first-class commercial quality and in accordance with best workshop practice and shall provide what is generally recognised as waterworks finish as defined elsewhere.

All similar items of plant and their component parts shall be completely interchangeable. Spare parts shall be manufactured from the same materials as the originals and shall fit all similar items of plant. Machining fits on renewable parts shall be accurate and to specified tolerances so that replacements made to the manufacturer's drawings may be readily installed.

All equipment shall operate without excessive vibration and with the minimum of noise. All revolving parts shall be dynamically balanced so that, when running at all operating speeds and any load up to the maximum, there is no vibration due to imbalance.

All parts that can be worn or damaged by dust shall be totally enclosed in dust-proof housings.

Dynamic balancing of rotary components shall be to the relevant standards. All bearings shall have an L-10 rating life of a minimum of 16,000 hours.

All instruments used for the works, whether for permanent installation or checks/inspections at the Manufacturer's works or checks/inspections at the site, shall be calibrated using standard reference instruments from institutions recognized by the Government, such as the Institute for Design of Electrical Measuring Instruments (IDEMI), Mumbai.

All outdoor instruments shall be provided with locked, galvanised metallic enclosures of 2 mm thickness, suitably painted.

4.5 Design Life

All materials and equipment shall be designed for long life and shall be suitable for continuous 24-hour per day operation for prolonged periods with a minimum of maintenance, and the Contractor may be called upon to demonstrate this for any component either by the service record of similar equipment elsewhere or by records of extensive type tests.

Routine maintenance and repair shall as far as possible, not require the services of highly skilled personnel.

Except for consumable items such as rubber bushings, gland packings, carbon brushes, etc., which generally require replacement more frequently, no part subject to wear shall have a life from new to replacement or repair of less than three years of continuous normal operation. Where significant dismantling is required to replace a part, such life shall be not less than fifteen years.

4.6 Welding

In all cases where welds are likely to be highly stressed, the Contractor shall supply the Engineer with detailed drawings of all welds and weld preparations proposed before fabrication commences. No welding shall be carried out before the Engineer has signified his approval of the proposed details. No alteration shall be made to any previously approved detail of weld preparation without prior approval of the Engineer.

Welding shall comply with BS EN 1011.

Approval of welding procedures shall be as per BS EN ISO 15614. Welders shall be qualified per BS EN 287-1:2004. All aspects of fabrication and examination procedures, including pre/post-heating treatment, electrodes, and Non-Destructive Tests (NDT), shall be subject to approval of the Engineer.

Contractor shall refer the relevant international codes for the NDTs.

4.7 Castings

All cast iron shall be of standard grey, close-grained quality, as per BS EN 1561/IS 210 Gr 220 Grade or better. The structure of the castings shall be homogeneous and free from non-metallic inclusions and other injurious defects. All surfaces of castings that are not machined shall be smooth and carefully fettled to remove all foundry irregularities.

Minor defects not exceeding 12.5 percent of the total metal thickness and that will not ultimately affect the strength and serviceability of the casting may be repaired by approved welding techniques. The Engineer shall be notified of larger defects, and no repair welding of such defects shall be carried out without prior approval.

If the removal of metal for repair reduces the stress-resisting cross-section of the casting by 25 percent, or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 percent, then that casting may be rejected.

Castings repaired by welding for major defects shall be stress relieved after such welding.

Non-destructive tests will be required for any casting containing defects whose extent cannot be otherwise determined, or to verify that repair welds have been properly made.

4.8 Instrument Components

Iron and steel parts shall, in general, be painted or galvanised as appropriate in accordance with the Specification. Indoor parts may alternatively have chromium or copper-nickel plating or other approved protective finish.

Small iron and steel parts (other than stainless steel) of all instruments and electrical equipment, the poles of electro-magnets and the metal parts of relays and mechanisms shall be chromium or copper-nickel plated or have some other approved finish to prevent rust Cores, etc., which are built up of laminations or cannot for any other reason be antirust treated, shall have all exposed parts thoroughly cleaned and heavily enamelled, lacquered or compounded.

4.8.1 Weatherproof Labels

These labels may be vitreous enamelled or brass. Plastic labels will not be accepted unless proof can be provided that they can withstand the environmental conditions at the site.

Vitreous enamelled labels shall be secured by brass or non-rusting roundhead screws, with brass and fibre washers in contact with the enamel front and back to prevent damage.

4.9 Lubrication

The contractor shall furnish a complete schedule of recommended oils and other lubricants. The number of different types of lubricants shall be kept to a minimum. The schedule and the name of the lubricant supplier shall be submitted to the Engineer for approval before being incorporated into the instruction manuals. In the case of grease-lubricated roller-type bearings for electric motors, lithium-based grease is preferred.

Where lubrication is effected by means of grease, preference shall be given to a pressure system which does not require frequent adjustment or recharging. Frequent, for this purpose, means more than once a week, and grease systems having shorter periods between greasing should be avoided. Where necessary for accessibility, grease nipples shall be placed at the end of the extension piping, and, when a number of such points can be grouped conveniently, the nipples shall be brought together and mounted in a convenient position. Button head type nipples shall be used for normal grease, and all grease nipples shall be of the same size and type for every part of the Plant. Arrangements shall be provided to prevent bearings from being overfilled with either grease or oil.

Where more than one special grease is required a grease gun for each special type shall be supplied and permanently labelled.

Oil lubricated bearings shall be provided with an oil reservoir capable of automatically maintaining the correct oil level within the bearings. It is not necessary to shut down the pump to check the oil level or add oil to the bearings.

Oil sumps shall be fitted with oil level indicators of the sight glass type, or where this is not practicable, with dipsticks. The indicators shall show the level at all temperatures likely to be experienced in service. The normal, maximum, and minimum levels at 20°C shall be clearly visible in the sight glass type from the normal access floor to the particular item of plant, and they shall be easily dismantled for cleaning.

All sight glasses shall be firmly held and enclosed in metal protection in a manner that prevents them from being accidentally dislodged.

All lubrication systems shall be designed to prevent a fire hazard, and particular care shall be taken to prevent the leakage of lubricants and to avoid lubricant leaks coming into contact with any electrical equipment, heated surfaces, or other potential sources of fire.

The Contractor shall supply flushing oil for each lubrication system when an item of plant is ready for preliminary running, and a sufficient quantity of the approved lubricants for setting to work and for the commercial operation of the plant for a period of two years after the taking over certificate has been issued.

4.10 Initial Charges of Oil and Grease, etc.

The initial charges of oil, grease, electrolyte, and similar materials necessary for the correct setting to work and operation of the Plant shall be included in the appropriate Plant item.

4.11 Non-metallic Materials

Fabrics, cork, paper, and similar materials that are not subsequently to be protected by impregnation shall be treated with an approved fungicide. Sleeving and fabrics treated with linseed oil varnish will not be permitted.

The use of organic materials shall be avoided as far as possible; however, where they are unavoidable, they shall be treated to make them fire-resistant and non-flame-propagating.

The use of wood should be avoided whenever possible. If used, woodwork shall be thoroughly seasoned teak or other approved hardwood that is resistant to fungal decay and other blemishes. All woodwork shall be treated to protect it against damage by fire, moisture, fungus, vermin, insects, bacteria, or chemical attack, unless it is naturally resistant to all these. All joints in woodwork shall be dovetailed or tongued and pinned. Metal fittings on wood shall be of non-ferrous material. Adhesives shall be specially selected to ensure the use of types that are impervious to moisture and fungus growth. Synthetic resin cement shall be used for joining wood.

4.12 Engineering Hardware

Nuts, bolts, studs, and washers for incorporation in the Works shall conform to the requirements of the appropriate British or other approved standard. Nuts and bolts for pressure fittings shall be made of the best quality steel, with the shank and under the head and nut being machined.

Bolts shall be of such a length that one thread shall show through the nut when in the fully tightened condition.

Fitted bolts shall be a light driving fit in the reamed holes they occupy, shall have the screwed portion of such a diameter that it will not be damaged in driving and shall be marked in a conspicuous position to ensure correct assembly at site.

Washers, locking devices, and anti-vibration fittings shall be provided as necessary to ensure that no bending stress is applied to the bolt.

Where there is a risk of corrosion, bolts and studs shall be designed so that the maximum stress in the bolt does not exceed half the yield stress of the material under all conditions.

All submerged hardware, including nuts, bolts, studs, washers, and fasteners, shall be made of SS316 material.

All bolts, nuts and screws which are subject to frequent adjustment or removal in the course of maintenance and repair shall be made of nickel-bearing stainless steel.

The Contractor shall supply all holding-down, alignment, and levelling bolts, complete with anchorages, nuts, washers, and packings, required to attach to its foundation. Additionally, the Contractor shall supply all bedplates, frames, and other structural parts necessary to spread the loads transmitted to the concrete foundations without exceeding the design stresses.

Unless otherwise necessary to meet special requirements, all threads shall be of preferred metric sizes with standard coarse threads.

ISO metric black hexagon bolts, nuts and screws shall comply with SII 0589-81, or ISO 885:2000, ISO 888:2018, ISO 898-1 and -2: 2013.

ISO metric precision hexagon bolts, nuts and screws shall comply with ISO 272:1982, ISO 4759-1:2000, ISO 885:2000, ISO 888:2018, ISO 898-1 and -2:2018 or ASTM F-593, ASTM F-468 M, strength grade 8.8.

The dimensions of ISO metric countersunk head bolts screws, and hexagon nuts shall comply with ISO 225:2010, or ISO 888:2018, ISO 898-I.

Plain steel washers for use with ISO metric bolts shall comply with ISO 887:2006 or ASTM F-844.

Taper steel washers shall comply with ASTM F-844 and ASTM F-436.

4.13 Instruments

Unless otherwise specified, any indicating and recording instruments supplied under the Contract shall be approved by the Engineer. They shall be flush-mounted, with dust- and moisture-proof covers, and shall be suitable for the environment in which they are installed. Where hinged covers are necessary, they shall be provided with locks.

Indicating instruments shall be of the dial type and shall be provided with a readily accessible zero adjustment.

Dials in general shall be white with black markings and not subject to fading. Scales shall be made of such material that no peeling or discoloration will occur with age under humid conditions.
Motor ammeters shall be capable of withstanding the starting current and shall have a compressed overload scale.

Steel screws, when used, shall be zinc, cadmium or chromium-plated, or where plating is not possible due to tolerance limitations, shall be of stainless steel. Instrument screws (except those forming part of a magnetic circuit) shall be of brass or bronze. Springs shall be non-rusting materials, eg, phosphor-bronze or nickel-silver, as far as possible. Pivots and other components for which non-ferrous materials are unsuitable shall be made of stainless steel.

Pressure gauges shall be at least 150 mm in diameter, unless otherwise approved. The internal components shall be made of stainless steel, bronze, or another corrosion-resistant material, excluding aluminium. The gauges may be mounted directly on the pipework or side by side on a board or panel. Each pressure gauge shall be fitted with a stop cock immediately adjacent to the gauge, and all pressure gauge piping shall be fitted with an isolating valve at each point of connection to the main system and drain valve for draining purpose. Where pressure gauges are mounted on panels, the isolating valve shall

be suitable for the connection of a test gauge. Stop cocks of gauges shall be clearly identified by means of separate labels of approved type and lettering.

All fixed pipes with a nominal bore below 25 mm shall be compression jointed with heavy-gauge copper, where this material is suitable. In other cases, pipe materials are to be approved by the Engineer. All pressure gauges shall be fitted with an air release cock and hydraulic pressure snubbers to protect them against shock pressures.

4.14 Gaskets and Joint Rings

Joint rings shall be manufactured to conform to BS 7874, BS EN 681-1, BS EN 681-2, and BS EN 682, and shall be made of chloroprene rubber or other approved synthetic materials suitable for temperatures up to 80 °C.

Joints shall be made in accordance with the manufacturer's instructions or as specified herein.

Until immediately required for incorporation in a joint, each rubber ring or gasket shall be stored in the dark, free from the deleterious effects of heat or cold, and kept flat to prevent any part of the rubber from being under tension.

Only lubricants recommended by the manufacturer shall be used in connection with rubber rings, and these lubricants shall not contain any constituent soluble in water of the quality stated in the Requirements, shall be suitable for the climatic conditions at the site, and shall contain an approved bactericide.

After cleaning the flanges, the gaskets shall be fitted smoothly to the flange and the joint made by tightening the nuts to finger pressure first. Thereafter the final tightening of the nuts shall be made by gradually and evenly tightening bolts in diametrically opposite positions using standard spanners.

Graphite grease shall be applied to the threads of bolts before joints are made.

4.15 Tools and test Equipment’s

The contractor shall supply the details of recommended special tools and test equipment required to enable any erection, dismantling, or testing to be carried out on any part of the Plant, whether of an electrical, mechanical, or any other nature, during the life of the Plant, and shall be listed in the Price Schedule. The cost of Tools and Test equipment shall not be taken into evaluation. It shall not be binding on the Employer to purchase any or all of the tools and test equipment recommended by the contractor. The tools and testing equipment required shall be specified prior to the award of the contract or during its execution and shall be binding on the contractor.

The tools and test equipment shall not be used for the erection of the Plant. Except as the Engineer may require the Contractor to demonstrate their use or effectiveness, they must be handed over to the Employer in a completely new and unused condition. Should the Contractor require any such tools and test equipment at the site during erection, he shall provide his own.

The tools for each type of equipment shall be contained in a suitable box, clearly marked, or labeled with its description. Each tool shall be identified, and a list of tools shall be affixed to the inside of the box lid. Each set of tools shall be supplied with the equipment with which it is associated.

The test equipment shall include only special-purpose items essential to the testing or recalibration of related plant items.

The tools provided shall include clamps, wrenches, lifting lugs, grease guns, gauges, test rigs, jigs, or extractors which may be required for the life of the plant. All tools and test equipment shall be clearly detailed, including size, capacity, etc.

4.16 Protection and Packaging for Transportation

Before any Plant is dispatched from a manufacturer's works, it shall be properly prepared and packed.

Prior to despatch, all Plant shall be adequately protected by painting or by other approved means for the whole period of transit, storage, and erection, against corrosion and incidental damage, including the effects of vermin, sunlight, rain, high temperatures, and humid atmospheres. The Contractor shall be held responsible for ensuring that the Plant is packed and/or protected to reach the site intact and undamaged. The Plant shall be packed to withstand rough handling in transit, and all packages shall be suitable for storage, including possible delays in transit.

The Contractor shall be deemed to have included in the Schedule of Prices for all materials and packing cases necessary for the safe packaging, conveyance, and delivery of the Plant.

The flanges of pipes, valves, and fittings shall be protected by wooden discs attached by means of service bolts (which shall not be used on-site) or by other approved means. The sleeves and flanges of flexible couplings shall be bundled by wire. Cases containing rubber rings, bolts, and other small items shall not normally weigh more than 500 kg gross.

No one package or bundle shall contain items of the plant intended for incorporation in more than one section of the works.

All items of Plant shall be clearly marked for identification against the packing list.

Every crate or package shall contain a packing list in a waterproof envelope. A duplicate copy of the packing list shall be sent by post to the Engineer at the site.

All crates, packages, and other items shall be clearly marked with a waterproof material to indicate the weight and the location where the slings should be attached. They shall also have an indelible identification mark relating them to the packing lists.

End of Part-4

PART 8

GENERAL MECHANICAL REQUIREMENTS

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PART 8

GENERAL MECHANICAL REQUIREMENTS

8.1 Valves

(a) Valves shall be as per internationally recognized standards. Flanges shall be machined on faces and edges. Flanges shall conform to ISO 7005, IS 6392, BS EN 1092-1/ BS 4504.

(b) Valves shall be double flanged type and the faces shall be parallel to each other. The flange face should be at right angles to the valve centre line. Back side of valve flanges shall be machined or spot faced for proper seating of the head and nut.

(c) Valves buried or installed in underground chamber, where access to a hand wheel would be impractical, shall be operated by means of extension spindle and/or keys. Wherever extension spindle is provided, the valve shall also be provided with suitable headstock.

(d) Valve of diameter 450 mm and above shall be provided with lifting eyes and shall have detachable bolted covers for inspection, cleaning, and servicing.

(e) Valve shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position.

(f) The valve stem, thrust washers, screws, nuts and all other components exposed to the water shall be of a corrosion resistant grade of stainless steel.

(g) Valves shall be free from sharp projections which are likely to catch and hold stringy material.

(h) All the valve shall be of 10 bar rating.

(i) All valves in the plant shall be provided with dismantling joint/Flexible joint/SS bellows for ease dismantling.

(j) ISPS / TSPS Pumping main shall be installed with Kinetic Air valve with isolation sluice at High points and Sluice valve as Scour connection at Low points.

(k) All the valves shall be provided with Bypass valve arrangement 10% of main valve size.

(l) 2 sets of ladders shall be provided in the raw sewage pumping station and chambers to facilitate access of valves.

8.1.1 Sluice Valve

(a) Sluice valve shall generally confirm to IS 14846.

(b) Sluice valves shall be of non-rising spindle type. The valve shall be furnished with a bushing arrangement for replacement of packing without leakage.

(c) Valves of 400 mm and above shall be provided with thrust bearing arrangement for ease of operation.

(d) Valves of diameter 400 mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear of all valves shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.

(e) All valves, spindles and hand wheels shall be positioned to give good access for operational personnel.

(f) All the hand wheels shall be arranged to turn in a clockwise direction to close the valve. The direction of rotation for opening and closing of the valve shall be indicated on the hand wheels.

(g) The material of construction of valve shall be as follows:

Component	**Material**
Body / Dome / Bonnet	SG Iron IS 1865 Gr. 500/7/GGG50 or 400/15/GGG40
Wedge	SG Iron IS 1865 Gr. 500/7/GGG50 or 400/15/GGG40
Spindle	Stainless Steel; ASTM A 276 Gr. 431 S29 /420
Thrust collar & Wedge Nut	Bronze: IS:318 Gr LTB2
Seals	Food Grade EPDM
O-Rings	NBR
Seat / face Rings	Bronze IS 318 Gr. LTB 2/SS 316
Back Seat Bush	Bronze IS 318 Gr. LTB2/SS 316
Shoe and Channel lining	Bronze IS 318 Gr. LTB2/SS 316
Internal Fasteners	SS 316
External Fasteners	SS 316
Gear, Gear housing	Cast Steel ASTM A 216 Gr. WCB

8.1.2 Knife Gate Valves

Design & Construction Details:

The Knife gate valves shall be manufactured generally as per the latest AWWA C520-10 standards.

Other constructional features and details of components of the required valves are to be as under:

The valve body should be of ductile iron construction as specified. The valve should be provided with gate made of stainless steel of grade as specified and the gate should have beveled knife edge at the bottom to cut through and easily enter in the solids settled in the bottom and ensure positive shut-off / closure in sewage environment.

The Valve should be designed for sealing in uni-directional flow application.

The valve should be provided with replaceable type flexible sealing arrangement to offer drop tight shut off. The seals should be made of EPDM rubber and should be held in place by an easily removable type seal retainer ring. The seals should be mechanically retained in place in a machined groove on the face of seal retainer ring. The sealing system should be field replaceable at site.

The valve housing should have integral as cast tapered lugs provided for pushing the gate towards the flexible rubber seal only at the verge of closure with a view to avoid seal wear and achieve drop tight shut off. The surface of the gate coming in contact with the seal should be polished & buffed.

The bonneted valves shall have glandless design to avoid repeated tightening / replacement of gland packing. The stuffing "O" ring seal should be pressurized by thrust washer from both the sides and should be pressurized / tighten by thrust retainer nut.

The packings should be of graphited synthetic yarn to reduce the friction and offer higher life. Provision shall be made to enable tighten the gland packing by means of a pusher arrangement to minimize the leakage through the back of the valve. Replacement of gland packings should be possible in installed condition of the valve without there being line pressure.

The spindle should be double start / single threaded and non-rising type for compact & safe operation. Gate opening indicating arrangement should be provided to find out the extent of gate opening /closing. The operation of the valves shall be manual / motorized as specified elsewhere in the tender specification.

In case the valve is to be operated from a far then it shall be provided with joining couplings, extension spindle, spindle guides and mounting pedestal with suitable anchor bolts / anchor fasteners on the platform.

Materials of construction:

Component	**Material**
Body	: Ductile iron (SG) IS 1865 Gr.400/12
Seal Retainer ring	: Stainless steel to ASTM A-351 Grade CF8M
Inlet Seal / Rubber Seals / O rings	: EPDM Rubber
Knife gate	: Stainless Steel ASTM A 240 type 316
Spindle	: Stainless Steel ASTM A 276 type 316
Assembly bolts, nuts and fastener	: Stainless Steel ASTM A 276 type 316
Spindle nut	: Gunmetal / Phosphor Bronze / Brass
Bracket / Adapter plate	: Mild Steel to IS: 2062 grade A, Epoxy Painted
Packing	: Graphited synthetic yarn

8.1.3 Air Valves

(a) The air valve must be of the type that incorporates a kinetic and an automatic air release valve in one unit. It should be able to release air (gases) and to admit air into the sewage line, when the line is emptied.

(b) The air valve must guarantee complete separation of liquid sewage from the sealing system of the air valve under all working conditions.

(c) The air valve must have arrangement for draining and flushing by external water.

(d) All sealing mechanism system parts of the air valve should be made of stainless steel-316.

(e) The body of the valve should be such as to minimise the accumulation of sewage deposit at the bottom of the coating or of cast iron. The valve mechanism must be such as to prevent opening of the air valve upon every slight pressure change in line. Air Valve shall be Epoxy powder coating shall be provided inside and outside.

(f) Each air valve must be supplied with a sluice vale for isolation for maintenance purpose.

Component	**Material**
Body/Top Cover	Ductile Iron Gr. GGG40/ GGG-50
Small orifice Plug	Leaded Tin Bronze IS 318 Gr. LTB 2/SS 316
Seat Ring	Leaded Tin Bronze IS 318 Gr. LTB 2/ SS 316
Float/Balls	SS AISI 304/ Polycarbonate
Cover Bolts	Austenitic alloy steel/SS 304
Gaskets & Seals	Food Grade EPDM

8.2 Approved Vendor/Manufacturer/Make List-Mechanical Equipment

The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering equipment. Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired.

	CONSOLIDATED Mechanical Equipment VENDOR LIST	
S.NO.	**ITEM DESCRIPTION**	**APPROVED VENDOR/ MANUFACTURER/ MAKE**
1	Sluice Valve for Sewage Application	M/s VAG
		M/s KBL
		M/s AVK Valves
		M/s Jupiter Valves
		M/s Indian Valve Company
		M/s Jupiter Valves

	CONSOLIDATED Mechanical Equipment VENDOR LIST	
S.NO.	**ITEM DESCRIPTION**	**APPROVED VENDOR/ MANUFACTURER/ MAKE**
		M/s Indian Valve Company
		M/s Beaver Process Equipment
		M/s Durga Valves
		M/s Yashwant
2	DI Pipe & DI Pipe Fittings	M/s Kiswok (For Fittings Only)
		M/s Kejriwal Castings
		M/s Jindal Saw
		M/s Electrotherm
		M/s Jupiter (For Fittings Only)
		M/s Electro steel Castings
3	Double Wall Corrugated (DWC) HDPE Pipes	M/s Jain Irrigation
		M/s Alom Extrusions
		M/s Prince
		M/s Supreme
		M/s Jagannath Industries
4	Knife Gate valves Sewage Application	M/s Jash Engineering (Scheutte)
		M/s Bray
		M/s Fouress
		M/s KBL
		M/s VAG
		M/s AVK
5	Air Valves Sewage Application	M/s KBL
		M/s ARI Valves
		M/s Jupiter Valves
		M/s Indian Valve Company
		M/s VAG Valves
		M/s AVK Valves
6	UPVC & HDPE Pipes	M/s Jain Irrigation
		M/s Finolex
		M/s Duraline
		M/s Manikya Palstichem
		M/s Pennwalt Agro
		M/s - Astral

	CONSOLIDATED Mechanical Equipment VENDOR LIST	
S.NO.	**ITEM DESCRIPTION**	**APPROVED VENDOR/ MANUFACTURER/ MAKE**
		M/s - Ashirwad
		M/s - Prince
		M/s - Supreme

All the equipment, to be supplied under this contract has to be from experienced manufacturer. The equipment of only those manufacturers, who have sufficient proven experience of manufacturing the respective equipment of similar capacity, shall be considered.

Note-1: In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service, like items of equipment provided hereunder shall be the end products of one (1) manufacturer.

Note-2: In the event that the contractor wishes to propose alternate makes for the equipment mentioned above, he shall submit the following during detailed engineering:

1) Demonstrate that the proposed makes are "equivalent " to the approved makes. The contractor shall ensure that alternate makes proposed, shall comply completely to the tender specifications, before the same is submitted for approval.
2) Submit ISO certificates for the OEM.
3) Submit quality certificates that the equipment adheres to, as required under this contract.
4) Submit product brochures for the proposed equipment, with information on spares availability and service setup in employer's country.
5) Manufacturer involved in manufacture of specified proposed equipment for at least 10 years before bid date
6) End user performance certificates for minimum 5 successful individual installations of similar size or capacity as per this contract with the proposed equipment and model no, commissioned and satisfactorily operating for at least 5 years before bid date.
7) Manufacturer to provide full contact information for each reference as part of submission.

And the above qualities and requirements shall be demonstrated and evidenced by inspection of manufacturing units and successfully installed plants (at the End users plant/premises) for the equipment's desired and successful operation and certification by the Employer/Engineer (BWSSB)/Representative.

The Employer shall reserve the right to accept or reject the Bidder proposed makes of Equipment.

8.3 Warranty

- Comply with the requirements of each type of Equipment and specification mentioned elsewhere in this document.
- Warrant all components to be free of defects in materials or workmanship for 12 months from date of Taking Over Certificate.

- Individual warranties by component manufacturer in lieu of single source responsibility by the main Equipment manufacturer shall not be acceptable.
- Items which fail during the warranty period, excluding expendable items, shall be replaced without cost to the Employer.
- Provide manufacturer's guarantee and warranty certificates prior to equipment start-up.

8.4 Pipelines, Pipe work and Fittings

8.4.1 Applicable codes

The following codes and standards unless specified herein shall be referred to, or equivalent to the approval of Engineer. All the Pipe material shall be as per IS/BS/JIS standards.

8.4.2 Materials

IS : 210	Specification for grey iron casting
IS : 290	Specification for coal tar black paint
IS : 456	Code of practice for plain and reinforced concrete
IS : 458	Specification for pre-cast concrete pipes (with and without reinforcement)
IS : 516	Method of test for strength of concrete
IS : 638	Specification for sheet rubber jointing and rubber insertion jointing
IS : 783	Code of practice for laying of concrete pipes
IS : 816	Code of practice for use of metal arc welding for general construction in mild steel
IS : 1367	Technical supply conditions for threaded steel fasteners
IS : 1387	General requirements for the supply of metallurgical materials
IS : 1500	Method for Brinell hardness test for metallic materials
IS : 1536	Specification for centrifugally cast (spun) iron pressure pipes for water, gas and sewage
IS : 1537	Specification for vertically cast-iron pressure pipes for water, gas and sewage
IS : 1538	Specification for cast iron fittings for pressure pipes for water, gas and sewage
IS : 1916	Specification for steel cylinder pipes with concrete lining and coating
IS : 2078	Method for tensile testing of grey cast iron
IS : 3597	Method of tests for concrete pipes
IS : 3658	Code of practice for liquid penetrant flow detection
IS : 5382	Specification for rubber sealing rings for gas mains, water mains and sewers
IS : 5504	Specification for spiral welded pipes
IS : 6587	Specification for spun hemp yarn
IS : 7322	Specification for specials for steel cylinder reinforced concrete pipes

8.4.3 Code of Practice

IS : 783	Code of practice for laying of concrete pipes
IS : 3114	Code of practice for laying of cast iron pipes

IS : 3764	Excavation work - Code of Safety
IS : 4127	Code of practice for laying of glazed stoneware pipes
IS : 5822	Code of practice for laying of electrically welded steel pipes for water supply.
IS : 6530	Code of practice for laying of asbestos cement pressure pipes.

8.4.4 Materials for Pipelines

Each pipeline shall be constructed in a material compatible with the fluid conveyed through that pipeline, i.e. the materials used in the pipes which are or can be in contact with the untreated or treated sewage, shall not contain any matter which could impart taste or odor or toxicity or otherwise be harmful to health or adversely affect the sewage conveyed. Nor shall any pipe be adversely affected by the fluid being conveyed through that pipe.

Pipe work and valve materials for the following duties shall be as follows or equivalent to the approval of the Engineer:

Table 8.1 Pipe work and Valve Materials

Application / Location	Material
Sewage Raw Sewage, Process sewage, dirty wastewater, supernatant and treated Sewage/Effluent, Process sludge	Mild steel with mortar lining/Guniting (Beyond 1200mm diameter of pipe) or Ductile Iron (Up to 1200mm) K9 class.
Service water	UPVC/HDPE (below 100 mm), ductile iron (100 mm and above).

8.5 Ductile Iron Pipes and Fittings

8.5.1 Pipes and Fittings

(a) General

Ductile iron pressure pipes and fittings (Class K9) shall comply with IS 8329 and IS 9523. All fittings shall be socketed unless specified otherwise.

(b) Materials

The materials used in the manufacture pipes and fittings shall comply with IS 8329 and IS 9523.

(c) Tests

Tests on pipes and fittings shall be carried out in accordance with IS 8329 and IS 9523. The test method shall be submitted for approval of Engineer.

The Engineer shall be permitted free access to the place of manufacture for the purpose of examining, inspection and witnessing the testing of pipes and fittings.

8.5.2 Joints

(a) Spigot and Socket Joints

These shall have sockets which are integral with the pipe and incorporate an elastomeric rubber ring gasket conforming to IS: 5382 (Latest edition/revision with amendments, if any).

(b) Flanged Joints

These shall comply with dimensions and drilling details shall be to BS EN 1092-1/BS: 4504 Table10/11 and16/11. All flanged joints between steel and ductile iron pipe work shall be electrically isolated joints. These shall have isolation gaskets between the flanges, isolation sleeves around all bolts and isolation washers under all bolt heads and nuts. All materials shall be supplied by a specialist manufacturer and be to the approval of the Engineer.

8.5.3 Linings

Ductile iron pipes and fittings shall have a cement mortar lining, in accordance with IS 11906 or ISO 4179.

Pipe linings shall be inspected on site and any damage or defective areas made good to the satisfaction of the Engineer. The Contractor may use specialist mortars, mortar additives or curing agents only with the approval of the Engineer.

Certain sections are amplified as follows:

No additives shall be used without the written approval of the Engineer and shall be used strictly in accordance with the manufacturer’s recommendations.

The minimum thickness of the lining at one point shall not be less than 4 mm or as per IS 8329.

8.5.4 Coating

(a) General

Ductile iron pipes and fittings shall be zinc coated with bitumen over coating, all in accordance with the following Specifications. Pipe coatings shall be inspected on site and any damage or defective areas made good to the satisfaction of the Engineer.

(b) Zinc Coating

Zinc coating shall comply with ISO 8179 and shall be applied as a spray coating. The mass of sprayed metal shall not be less than 130 g/m^2 as described in Clause 5.2 of ISO 8179.

(c) Bitumen Coating

Bitumen coating shall be of normal thickness 0.07 mm unless otherwise specified. It shall be a cold applied compound complying with the requirements of BS 3416 Type II, suitable for tropical climates, factory applied in accordance with the manufacturer's instructions.

Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe.

(d) Polythene Sleeving

Where polythene sleeving is specified (generally for all buried DI pipes need sleeve covering) to be applied in addition to bitumen coating it shall comply with ISO 8180. Site applied sleeving shall be stored under cover, out of direct sunlight, and its exposure to sunlight shall be kept to a minimum. Pipes having a factory applied sleeving must be stored in the same conditions.

8.6 Reinforced Cement Concrete Pipes

8.6.1 Design

Design of RCC pipes including reinforcement details and the ends of pipes shall be in accordance with the relevant clauses of IS: 458.

General

The method of manufacture shall be such that the form and the dimensions of the finished pipes are accurate within the limits specified in relevant clause of IS: 458. The surfaces and edges of the pipes shall be well defined and true, and their ends shall be square with the longitudinal axis. The ends of the pipes shall be further reinforced by an extra ring of reinforcement to avoid breakage during transportation.

The RCC pipes and collars/rubber rings shall be systematically checked for any manufacturing defects by experienced supervisors so as to maintain a high standard of quality.

The Engineer shall at all reasonable times have free access to the place where the pipes and collars/rubber rings are manufactured for the purpose of examining and testing the pipes and collars/ rubber rings and of witnessing the test and manufacturing.

All tests specified either in this Employer's Requirements or in the relevant Indian standards shall be performed by the supplier/contractor at his own cost and in presence of the Engineer if desired. For this, sufficient notice before testing of the pipes and fittings shall be given to the Engineer.

If the test is found unsatisfactory, the Engineer may reject any or all pipes of that lot. The decision of the Engineer in this matter shall be final and binding on Contractor and not subject to any arbitration or appeal.

8.6.2 Materials

For all materials Factory's test result, and written guarantee document with necessary analysis data shall be submitted to obtain the approval of the Engineer before carrying to sites.

(a) Cement

Cement shall be used for the manufacture of sulphate resistant cement RCC pipes and collars shall conform to relevant IS codes. The use of pozzolana as an admixture to Portland cement shall not be permitted.

(b) Aggregates

Aggregates used for the manufacture of RCC pipes and collars shall conform to IS: 383. The maximum size of aggregate should not exceed one third the thickness of the pipe or 20mm, whichever is smaller.

(c) Mixing and Curing Water

Water shall be clean, Colour less and free from objectionable quantities of organic matter, alkali, acid, salts, or other impurities that might reduce the strength, durability or other desirable qualities of concrete and mortar. Contractor shall submit water quality report before using it.

(d) Reinforcement

Reinforcement used for the manufacture of the RCC pipes and collars shall be mild steel Grade I or medium tensile steel bars conforming to IS: 432 (Part-1) or hard-drawn steel wire conforming to IS: 432 (part-2). Reinforcement cages for pipes and collars shall be as per relevant requirement of IS:458.

(e) Concrete

Concrete used for the manufacture of RCC pipes and collars shall conform to IS: 456. The minimum cement content and minimum compressive strength of concrete shall be as per relevant requirements of IS: 458. Compressive strength tests shall be conducted on 15 cm cubes in accordance with the relevant requirements of IS: 456 and IS: 516.

(f) Curing

Pipes manufactured in compliance with IS: 458 shall be either water cured or steam cured in accordance with the relevant requirements of IS: 458.

(g) Dimensions

The internal diameter, wall thickness and length of barrel and collar of pipes, reinforcement (longitudinal and spiral), type of ends and minimum clear cover to reinforcement and strength test requirements shall be as per the relevant clauses / tables of IS:458 for different classes of pipes.

The tolerances regarding overall length, internal diameter of pipes or sockets and barrel wall thickness shall be as per relevant clause of IS: 458.

(h) Workmanship and Finish

Pipes shall be straight and free from cracks. The ends of the pipes shall be square with their longitudinal axis so that when placed in a straight line in the trench no opening between ends in contact shall exceed 3 mm in pipes upto 600mm diameter (inclusive), and 6 mm in pipes larger than 600 mm diameter.

The outside and inside surfaces of the pipes shall be smooth, dense and hard, and shall not be coated with cement wash or other preparation unless otherwise agreed to between the Engineer and the manufacturer or supplier.

The pipes shall be free from defects resulting from imperfect grading of the aggregate, mixing or moulding.

The pipes shall be free from local dents or bulges greater than 3 mm in depth and extending over a length in any direction greater than twice the thickness of barrel.

The deviation from straight in any pipe throughout its effective length, tested by means of rigid straight edge parallel to the longitudinal axis of the pipe shall not exceed, for all diameters 3 mm for every meter run.

(i) Testing

All pipes for testing purposes shall be selected at random from the stock of the manufacturer and shall be such as would not otherwise be rejected under the criteria of tolerances as mentioned in IS 458. Engineer reserve the right to attend all testing.

During manufacture, tests on concrete shall be carried out as per IS: 456. The manufacturer shall supply, when required to do so by the Engineer the results of compressive tests of concrete cubes and split tensile tests of concrete cylinders made from the concrete used for the pipes. The manufacturer shall supply cylinders or cubes for test purposes required by the Engineer and such cylinders or cubes shall withstand the tests prescribed as per IS 458. Every pressure pipe shall be tested by the manufacturer for the hydrostatic test pressure. For non-pressure pipes, 2 percent of the pipes shall be tested for hydrostatic test pressure.

The specimen of pipes for the following tests shall be selected in accordance with relevant clause of IS: 458 and tests in accordance with the methods described in IS: 3597.

i) Hydrostatic test
ii) Three edge bearing test
iii) Absorption test
iv) Visual Examination

(j) Sampling and Inspection

In any consignment, all the pipes of same class and size and manufactured under similar conditions of production shall be grouped together to constitute a lot. The conformity of a lot to the requirements of this Employer's Requirements shall be ascertained on the basis of tests on pipes selected from it.

The number of pipes to be selected from the lot for testing shall be in accordance with Table 15 of IS: 458.

Pipes shall be selected at random. In order to ensure randomness, all the pipes in the lot may be arranged in a serial order and starting from any pipe, every pipe be selected till the requisite number is obtained, or being the integral part of N/n where N is the lot size and n is the sample size.

All pipes selected shall be inspected by Engineer for dimensional requirements, finish and deviation from straight. A pipe failing to satisfy one or more of these requirements shall be considered as defective.

The number of pipes to be tested shall be in accordance with column 4 of Table 15 of IS:458. These pipes shall be selected from pipes that have satisfied the requirements mentioned in the above clause.

A lot shall be considered as conforming to the requirements of IS:458 if the following conditions are satisfied.

The number of defective pipes shall not be more than the permissible number given in column 3 of Table 15 of IS: 458.

All the pipes tested for various tests shall satisfy corresponding requirements of the tests.

In case the number of pipes not satisfying requirements of any one or more tests, one or two further samples of same size shall be selected and tested for the test or tests in which the failure has occurred. All these pipes shall satisfy the corresponding requirements of the test.

All result of tested data must be prepared by contractor at site so that the Engineer shall make decision of "fail or pass" at once. All cost for the test shall be borne by the Contractor.

(k) Marking

The following information shall be clearly marked on each pipe:

a) Internal and External diameter and length of pipe
b) Class of pipe
c) Date of manufacture and
d) Name of manufacturer or his registered trade-mark or both.

8.6.3 Jointing

General

Jointing of RCC pipes shall be done as per the requirements of following Employer's Requirements and as per the relevant IS standard. After jointing, extraneous material, if any, shall be removed from the inside of the pipe and the newly made joints shall be thoroughly cured. In case, rubber sealing rings

are used for jointing, these shall conform to IS: 5382. The pipe joint work must be done neatly and keep even slope and level for pipe laying works.

(a) Spigot and Socket joint (Rigid)

The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. The opening of the joint shall be filled with stiff mixture of cement mortar which shall be rammed with caulking tool. This joint is used for low pressure pipe line.

(b) Collar Joint (Rigid)

After laying the RCC pipes at proper alignment and gradient their abutting faces shall be coated with hot bitumen in liquid condition by means of a brush. The wedge-shaped groove in the end of the pipe shall then be filled with a tarred gasket in one length for each joint. The collar shall then be slipped over the end of the pipe and the next pipe butted well against the tarred gasket by suitable appliances approved by the Engineer so as to thoroughly compress the tarred gasket into the grooves, care being taken that the concentricity of the pipes and levels are not disturbed during this operation.

The collar shall then be place symmetrically over the end of the two pipes and the space between the inside of the collar and the outside of the pipe filled with a mixture of cement and sand to withstand any stress and prevent any water leakage, tempered with just sufficient water to have a consistency of the semi-dry conditions, well packed and thoroughly rammed with caulking tools. The joints shall be finished off with a fillet sloping at 45^0 to the side of the pipe. The finished joints shall be protected and cured thoroughly as directed by the Engineer. Any plastic solution or cement mortar that may have been squeezed into the inside of the pipe shall be removed so as to leave the inside of the pipe perfectly clean.

(c) Flush Joint (Internal)

This joint shall be generally used for culvert pipes of 900 mm diameter and over. The ends of the pipes are specially shaped to form a self-centering joint with an internal jointing space 13 mm wide. The finished joint is flush with both inside and outside with the pipe wall. The jointing space is filled with cement mortar mixed sufficiently dry to remain in position when forced with a trowel or rammer.

(d) Flush Joint (External)

This joint is suitable for pipes which are too small for jointing from inside. This joint is composed of specially shaped pipe ends. Each end shall be butted against each other and adjusted in correct position. The jointing space shall then be filled with cement mortar sufficiently dry and finished off flush. Great care shall be taken to ensure that the projecting ends are not damaged as no repairs can be readily affected from inside the pipe.

(e) Spigot and Socket (Semi-flexible)

This joint is composed of specially shaped spigot and socket ends on the RCC pipes. A rubber ring shall be lubricated and then placed on the spigot which is forced into the socket of the pipe previously laid. This compresses the rubber ring as it rolls into the annular space formed between the two surfaces of

the spigot and socket, stiff mixture of cement and mortar shall then be filled into the remaining annular space with a caulking tool.

(f) Collar Joint (Semi-Flexible)

This joint is made up of a loose collar which covers two specially shaped pipe ends. Each end shall be fitted with a rubber ring which when compressed between the spigot and collar, seals the joint. Stiff mixture of cement mortar shall then be filled to withstand stress and prevent any water leakage, into the remaining annular space and rammed with a caulking tool.

(g) Spigot and Socket Joint (Flexible)

The RCC pipe with the rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previously laid pipe by means of uniformly applied pressure with the aid of a jack or similar appliance. The RCC pipes shall be of spigot and socket type and rubber rings shall be used, and the manufacturer's instructions shall be deemed to form a part of these Employer's Requirements. The rubber rings shall be lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

(h) Cleaning of Pipes

As soon as a stretch of RCC pipes has been laid complete from manhole to manhole or for a stretch as directed by the Engineer, Contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75 mm less in diameter than the internal diameter of pipes. The open end of an incomplete stretch of pipeline shall be securely closed as may be directed by the Engineer to prevent entry of mud or silt etc.

If as a result of the removal of any obstructions the Engineer considers that damages may have been caused to the pipelines, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory, contractor shall amend the work and carry out such further tests as are required by the Engineer.

It shall also be ascertained by contractor that each stretch from manhole to manhole or the stretch as directed by Engineer is absolutely clear and without any obstruction by means of visual examination of the interior of the pipe line suitably enlightened by projected sunlight or otherwise.

(i) Testing at work site

After laying and jointing of RCC pipes is completed the pipe line shall be tested at work site as per the following Employer's Requirements and as directed by the Engineer. All equipment for testing at work site shall be supplied and erected by contractor. Water for testing of pipes shall be arranged by him. Damage during testing shall be contractor's responsibility and shall be rectified by him to full satisfaction of the Engineer. Water used for the test shall be removed from pipes and not released to the excavated trenches.

After the joints have thoroughly set and have been checked by the Engineer and before back filling the trenches, the entire section of the sewer or storm water drain shall be proved by the contractor to be water tight by filling in pipes with water to the level of 1.50m above the top of the highest pipe in the stretch and heading the water up for a period of one hour. The apparatus used for the purpose of testing shall be approved by the Engineer. Contractor if required by the Engineer shall dewater the excavated pit and keep it dry during the period of testing. The loss of water over a period of 30 minutes should be measured by adding water from a measuring vessel at regular 10 minutes intervals and noting the quantity required to maintain the original water level. For the approval of this test the average quantity added should not exceed 1 liter/ hour/100 linear metres/10 mm of nominal internal diameter. Any leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work should be removed and made good.

In case of pressure pipeline, the completed stretch of pipeline shall be tested for site test pressure. The site test pressure should not be less than the maximum operating pressure plus the calculated surge pressure, but in no case should it exceed the hydrostatic test pressure as specified in IS: 458.

All of results of test and inspection data must be prepared by contractor at site so that the Engineer shall make decision of "fail or pass" at once. All cost for the inspection shall be borne by the Contractor.

8.7 Cast Iron Pipes

8.7.1 Manufacturing

(a) General

C.I. pipes and fittings shall be systematically checked for any manufacturing defects by experienced supervisors and a very high standard of quality shall be maintained.

Engineer shall at all reasonable times have free access to the place where the pipes and fittings are manufactured for the purpose of examining and testing the pipes and fittings and for witnessing the test and manufacturing.

All tests specified either in this Employer's Requirements or in the relevant Indian Standards shall be performed by the supplier/contractor at his own cost and in presence of the Engineer if desired. For this, sufficient notice before testing of the pipes and fittings shall be given to the Engineer.

If the test is found unsatisfactory, the Engineer may reject any or all pipes and fittings of that lot. The decision of the Engineer in this matter shall be final and binding of the Contractor and not subject to any arbitration or appeal.

(b) Materials

The general requirements relating to the supply of material shall be as per IS: 1387.

The material for pipes and fittings shall be of good quality cast iron conforming to IS: 210 (Grade -FG 150).

(c) Dimensions

The internal diameter, thickness and length of barrel, dimensions of pipes and fittings shall be as per the relevant tables of IS: 1536/1537/1538 for different class of pipes and fittings.

The tolerances for pipes and fittings regarding dimensions and deviations from straight line in case of pipes shall be as per relevant IS codes.

The standard weight of uncoated pipes and fittings and the permissible tolerance shall be as per relevant IS codes.

(d) Workmanship and Finish

The pipes and fittings shall be stripped, with all precautions necessary to avoid warping or shrinking defects. The pipes and fittings shall be free from defects, other than any unavoidable surface imperfections which result from the method of manufacture and which do not affect the use of the pipes in the opinion of Engineer.

The pipes and fittings shall be such that they could be cut, drilled or machined and may be accepted provided the hardness of the external unmachined surface does not exceed 230 HBS. In the case of spigot and socket pipes and fittings for lead joints, the socket shall be without the centering ring.

In the case of flanged pipes the flanges shall be at the right angles to the axis of the pipe and machined on face. The bolt holes shall be drilled and located symmetrically off the centre line. The bolt hole circle shall be concentric with the bore and bolt holes equally spaced. The flanges shall be integrally cast with the pipes and fittings and the two flanges of the pipe shall be correctly aligned.

(e) Testing

(i) Mechanical Tests

Mechanical tests shall be carried out during manufacture of pipes and fittings as specified in relevant IS codes. The results so obtained shall be considered to represent all the pipes and fittings of different sizes manufactured during that period and the same shall be submitted to the Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per relevant IS codes.

(ii) Brinell Hardness Test

For checking the Brinell hardness, the test shall be carried out on the test ring or bars cut from the pipes used for the ring test and tensile test in accordance with IS 1500.

(iii) Retests

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements, the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

(iv) Hydrostatic test

For hydrostatic test at works, the pipes and fittings shall be kept under test pressure as specified in relevant IS codes for 15 seconds, they may be struck moderately with a 700 g hammer. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. The hydrostatic test shall be conducted before coating the pipes and fittings.

(f) Coating

Coating shall not be applied to any pipe and fitting unless its surface is clean, dry and free from rust. All pipes and fittings shall be coated externally and internally with the same material, by dipping in a tar or suitable base bath. The pipe and fitting may be either preheated before dipping or the bath may be uniformly heated. The coating material shall set rapidly with good adherence and shall not scale off. In all instances where the coating material has a tar or similar base, it shall be smooth and tenacious and hard enough not to flow when exposed to a temperature of 65^{o} C, but not so brittle at a temperature of 0^{0}C as to chip off when scribed lightly with a penknife. In case of pipes and fittings which are imperfectly coated or where the coating does not set or conform to the required quality, the coating shall be removed and the pipes and fittings recoated.

In case the pipes are to be used for conveying potable water, the inside coating shall not contain any constituent soluble in such water or any ingredient which could impart any taste or odour whatsoever to the potable water after disinfection and suitable washing of the mains.

(g) Marking

Each pipe and fitting shall have cast, stamped or indelibly painted on it the following appropriate marks:

i) The nominal diameter.
ii) Flow direction and line marks for installation
iii) Class reference
iv) Mass of pipe
v) Date of manufacture and
vi) Manufacturer's name, initials or identification mark.

Marking shall be done as per relevant IS code.

8.7.2 Jointing

(a) General

Jointing of CI pipes and fittings shall be done as per the requirements of following Employer's Requirements and as per the relevant IS. After jointing, extraneous material, if any, shall be removed from the inside of the pipe. In case, rubber sealing rings are used for jointing, these shall conform to IS: 5382.

(b) Tyton joints

In jointing cast iron spigot and socket pipes and fittings with tyton flexible joints the contractor shall take into account the manufacture's recommendations as to the methods and equipment to be used in assembling the joints. In particular the contractor shall ensure that the spigot end of the pipe to be jointed is smooth and has been properly chamfered, that the rubber ring as per IS: 5382, is correctly positioned in line, before the joint is made. The rubber rings and any recommended lubricant shall be obtained only through the pipe supplier or as otherwise directed by Engineer.

(c) Flanged Pipes

The gaskets used between flanges of pipes shall be compressed fibre board or natural/synthetic rubber conforming to IS: 638, of thickness between 1.5 to 3 mm. The fibre board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per square metre shall be not less than 112 g/mm thickness.

Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternately. The practice of fully tightening the bolts one after another is highly undesirable. The bolts shall be of mild steel unless otherwise specified.

(d) Cleaning of Pipes and Fittings

The Contractor shall ascertain that each stretch of pipeline is absolutely clear and without any obstruction by means of visual examination of the interior of pipeline suitably lighted by projected sunlight or otherwise. The open end of an incomplete stretch of pipeline shall be securely closed as may be directed by the Engineer to prevent entry of mud or silt etc.

If as a result of the removal of any obstructions the Engineer considers that damages may have been caused to the pipeline, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory, contractor shall amend the work and carry out such further tests as are required by the Engineer.

(e) Testing at work site

After the pipes and fittings are laid, jointed and the trench partially backfilled except at the joints the stretch of pipe line as directed by Engineer shall be subjected to pressure test and leakage test. Where any section of the pipeline is provided with concrete thrust blocks or anchorages, the pressure test shall not be made until at least five days have elapsed after the concrete was cast. If rapid hardening cement

has been used in these blocks or anchorages, the tests shall not be made until atleast two days have elapsed.

Each section of the pipe line shall be slowly filled with water and all air shall be expelled from the pipe by tapping at points of highest elevation before the test is made and plugs inserted after the tests have been completed. The specified test pressure based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe as directed by the Engineer.

The duration of test shall not be less than 5 minutes. The exposed joints shall be carefully examined and all such joints showing visible leaks shall be recaulked until water tight. Any cracked or defective pipes and fittings in consequence of this pressure test shall be removed and replaced by sound material by Contractor at no extra cost to the Engineer and the test shall be repeated to the satisfaction of the Engineer.

After the satisfactory completion of pressure test, the section of pipe line shall be subjected to leakage test. The duration of test shall be 2 hours. No pipe installation shall be accepted until the leakage is less than the number of cm3 /h as determined by the formula:

$$q_L = \frac{ND\sqrt{P}}{3.3}$$

Where,

q_L	=	The allowable leakage in cm^3/hr
N	=	Number of joints in the length of the pipeline
D	=	Diameter in mm, and
P	=	The average test pressure during the leakage test in Kg/cm^2

Should any test of pipe laid indicate leakage greater than that specified above, the defective joints shall be repaired by Contractor at no extra cost to the Engineer until the leakage is within the specified allowance.

Necessary equipment and water used for testing shall be arranged by Contractor at his own cost. Damage during testing shall be Contractor's responsibility and shall be rectified by him at no extra cost to the Engineer. Water used for testing shall be removed from the pipe and not released in the excavated trenches.

After the tests mentioned above are completed to the satisfaction of the Engineer, the backfilling of trenches shall be done as per the Employer’s Requirements specified elsewhere.

8.8 Un plasticised PVC Pipes and Fittings

Unplasticised polyvinyl chloride pipes, fittings and specials shall be to BS 3505 for potable water and BS 4346: Part 1 for fittings.

The pipes shall be of the spigot and socket type with approved gasket type flexible joint. The rubber gaskets shall be to BS 2494, Class C.

Where PVC pipes, fittings and specials are to be connected to cast iron, stainless steel or steel pipes, all metallic pipes, 'Viking Johnson' type flange adaptors or stepped couplings shall be used.

(a) Polyethylene Pipes

Polyethylene pipes shall comply with BS 6437. The welding method shall be adapted to international standard and contractor shall obtain the approval of the Engineer before proceeding with such works.

(b) Rubber Hosing

Rubber hosing shall conform to BS 5119, Type 2. It shall be capable of handling chlorine and sulphur dioxide solutions at a working pressure of 12 bar.

(c) Copper Tubes and Fittings

Copper tubing and fittings for work above ground level shall comply with BS 2871 and BS 864: Part 2 respectively and be jointed with capillary joints. For underground location the copper pipe shall be to BS 2871: Part 1.

(d) Flanged Joints

All flanges shall comply with BS EN 1092-1/BS 4504. The nominal pressure rating for particular flanges shall be at least equal to the highest pressure rating of the pipes or fittings to which they are attached, but with a minimum nominal pressure of PN 10. All flanges shall be provided with all necessary nuts, bolts, washers and gaskets. In general, valves shall have flanged body ends.

All flanged joints which are buried or in chambers shall be protected with Densomastic and Densotape wrapping, applied in accordance with the manufacturer's instructions.

Flanges shall be installed on the pipes in the factory and field welding of flanges shall only be allowed with the approval of the Engineer.

Where pipework outside pumping stations and surge vessel chambers is catholically protected, an insulated flange shall be incorporated at the first flange inside the structure. These flanges shall be tested to ensure that electrical insulation is achieved.

(e) Gaskets and Joint Rings

Joint rings shall be manufactured to conform with BS 2494 and shall be of chloroprene rubber or other approved synthetic material suitable for temperatures up to 80^{o}C.

Gaskets may be inside the bolt circle type and shall comply with BS 4865: Part 1. Alternatively the gasket shall be to the full diameter of the flange, drilled to suit the appropriate bolt provisions.

Chloroprene rubber with a hardness of 71 to 80 IRHD shall be used.

Joints shall be made in accordance with manufacturer's instructions or as specified herein.

Until immediately required for incorporation in a joint, each rubber ring or gasket shall be stored in the dark, free from the deleterious effects of heat or cold, and kept flat so as to prevent any part of the rubber being in tension.

Only lubricants recommended by the manufacturer shall be used in connection with rubber rings and these lubricants shall not contain any soluble constituent, shall be suitable for the climatic conditions at the Site and shall contain an approved bactericide.

After cleaning the flanges the gaskets shall be fitted smoothly to the flange and the joint shall be made by tightening the nuts to finger pressure first. Thereafter the final tightening of the nuts shall be made by gradually and evenly tightening bolts in diametrically opposite positions using standard spanners.

Graphite grease shall be applied to the threads of bolts before joints are made.

(f) Flexible Couplings and Flange Adaptors

Flexible couplings and flange adaptors shall be of the Viking Johnson or similar approved pattern and be assembled in accordance with the manufacturer's instructions and protected, if buried or in chambers with Densomastic and Densotape wrapping applied in accordance with the manufacturers' instructions. Flexible joints shall be harnessed or tied where necessary

8.9 Storage & Shipment

(a) Protection of Pipes and Fittings for Shipment

Except where otherwise specified all items shall have received their complete protective coatings before dispatch from the manufacturer's works and shall be additionally protected by approved means for the period of transit, storage and erection, against corrosion and accidental damage.

For the protection of pipe linings and in particular for protecting cement mortar linings from drying out, protective metal or timber discs shall be fitted over the ends of pipes and fittings. Similar timber protective discs shall be attached to all flanges of pipes and fittings, by means of bolts specifically provided for the purpose and which shall be discarded when the item is incorporated in the Works. The sleeves and flanges of flexible joints shall be wired together in suitable bundles.

(b) Storage of Pipeline Materials

Pipes and fittings shall be stored raised off the ground, and shall be carefully supported, cushioned and wedged. Pipes shall not rest directly on one another and shall not be stacked more than four pipes high or two pipes high in the case of pipes of 500 mm diameter or over. Special care shall be taken to ensure that flexible pipes are cradled and supported in a manner that prevents any distortion of the pipes.

Couplings and joints (and all components thereof) and other similar items shall be stored in dry conditions, raised from the ground in sheds or covered areas.

Storage areas shall be carefully set out to facilitate unloading, and checking of materials with different consignments stacked or stored separately with identification marks clearly visible.

Where items to be stored have a limited shelf life or require special storage arrangements, the method of storage shall be to the approval of the Engineer and in accordance with the manufacturer's instructions.

All pipes and fittings supplied as spares shall have end covers which are proof against the entry of sand and vermin. Mortar lined pipes and fittings shall have end covers which form a complete seal, provision being made to accommodate the effects of temperature changes. Pipes and fittings supplied as spares shall have a temporary white external finish and shall be stored sheltered from the direct rays of the sun.

End covers and protection shall not be removed until incorporation of the pipes and fittings into the Works.

8.10 Transportation of Pipes and Fittings

Any vehicle on which pipes are transported shall have a body of such length that the pipes do not overhang. Large pipes shall be placed on cradles and the loads properly secured during transit. The pipes shall be handled in accordance with the manufacturer's recommendations.

Approved slings shall be used and all hooks and dogs and other metal devices shall be well padded. Hooks engaged on the inner wall surface at pipe ends shall not be used. Steadying ropes shall be employed. The positions of lifting slings shall ensure that stresses and tendency towards deformation in the pipes are kept at a minimum.

Pipe handling equipment shall be maintained in good repair and any equipment which in the opinion of the Engineer may cause damage to the pipes shall be discarded.

Under no circumstances shall pipes be dropped, be allowed to strike one other, be rolled freely or dragged along the ground.

8.11 Inspection of Pipes and Fittings

Before incorporating into the Works each pipe shall be brushed out and carefully examined for soundness. Damaged pipes which in the opinion of the Engineer cannot be satisfactorily repaired shall be rejected and removed from Site.

Damage to pipe coatings or linings shall be repaired to the satisfaction of the Engineer.

Built-in Pipe work and other Plant

The pipes and other Plant in water retaining structures shall, wherever possible, be built in as the work on the structure proceeds. The Contractor shall ensure that delivery of the requisite pipe work and other Plant is in accordance with the requirements of the programme.

Where a pipe subject to thrust passes through a concrete structure or where an external seal is required, a puddle flange shall be used. The puddle flange dimensions shall be to BS EN 1092-1/BS 4504 but shall be undrilled. The exterior of the pipe shall be cement washed symmetrically about the puddle flange by the manufacturer for a length at least equivalent to the thickness of the wall through which it passes.

The Contractor shall be responsible through every stage of the Works for checking the correctness of the setting of built-in Plant and shall satisfy himself they are positioned in accordance with his approved drawings.

8.12 Pipe laying

(A) Carting & Handling

Pipes and fittings /specials shall be transported from the factory to the work sites at places along the alignment of pipeline as directed by the Engineer. Contractor shall be responsible for the safety of pipes and fittings/specials in transit, loading/unloading. Every care shall be exercised in handling pipes and fittings/specials to avoid damage. While unloading, the pipes and fittings/specials shall not be thrown down from the truck on to hard surfaces. They should be unloaded on timber skids with steadying ropes or by any other approved means. Padding shall be provided between coated pipes, fittings/specials and timber skids to avoid damage to the coating. Suitable gaps between pipes should be left at intervals in order to permit access from one side to other. In case of spigot socket pipes, care should be taken regarding orientation of pipes while unloading. As far as possible pipes shall be unloaded on one side of the trench only. The pipes shall be checked for any visible damage (such as broken edges, cracking or spalling of pipe) while unloading and shall be sorted out for reclamation. Any pipe which shows sufficient damage to preclude it from being used shall be discarded. Dragging of pipes and fittings/specials along concrete and similar pavement with hard surfaces shall be prohibited.

(B) Storage

Each stack of pipes shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible. Storage shall be done on firm level and clean ground and wedges shall be provided at the bottom layer to keep the stack stable. The stack shall

be in pyramid shape or the pipes laid lengthwise and crosswise in alternate layers. The pyramid stack shall be made for smaller diameter pipes for conserving space in storing them. The height of the stock shall not exceed 1.5 m.

Fittings/Specials shall be stacked under cover and separated from pipes.

Rubber rings shall be stored in a clean, cool store away from windows, boiler, electrical equipment and petrol, oils or other chemicals. Particularly in the field where the rubber rings are being used it is desirable that they are not left out on the ground in the sun or overnight under heavy frost or snow conditions.

8.13 Laying

(A) Excavation

Before excavating the trench, the alignment of pipeline shall be approved by the Engineer. The excavation of trenches and pits for manholes/ chambers shall be carried out in accordance with the Employer's Requirements described elsewhere and shall be done such that it does not get far ahead of the laying operation as approved by the Engineer.

To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, red lanterns and guards as required shall be placed and maintained during the progress of the construction work and until it is safe for the traffic to use the roadways. The relevant Indian Standards and the rules and regulations of local authorities in regards to safety provisions shall be observed.

Suitable fencing shall be provided along the sides of trenches and pits. The posts of fencing shall be of timber securely fixed in the ground not more than 3 m apart and they shall not be less than 75 mm in diameter or less than 1.2m above surface of the ground. There shall be two rails, one near the top of the post and the other about 450mm above the ground and each shall be from 50mm to 70mm in diameter and sufficiently long to run from post to post to which they shall be bound with strong rope. The method of projecting rails beyond the post and tying them together where they meet will not be allowed on any account. All along the edges of the excavation trenches a bank of earth about 1.2 m high shall be formed where required by the Engineer for further protection.

The road metal and also the rubble packing shall first be stripped off for the whole width of the trench/pit and separately deposited in such place or places as may be determined by the Engineer.

During excavation, large stones and rubble shall be separated and removed from the excavated soil and stacked separately. The material from excavation shall be deposited on either side of the trench leaving adequate clear distance from the edges of the trench and pit, or as may be necessary to prevent the sides of the trench pit to slip or fall, or at such a distance and in such a manner as to avoid covering fire hydrants, sluice valves, manholes and covers etc. and so as to avoid abutting the wall or structure or causing inconvenience to the public and other service organizations or otherwise as the Engineer may direct.

Contractor shall take into account additional excavation if any as the Engineer may require in order locating the position of water pipes, drains, sewers etc. or any other works which may be met with, in or about the excavation of trenches/pits while quoting the rates for excavation of trenches /pits while quoting the rates of excavation. Such service lines if met with during excavation shall be properly maintained by Contractor, by means of shoring, strutting, planking over, padding or otherwise as the Engineer may direct, and shall be protected by the Contractor from damage during the progress of the work. All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure /pipe line of water, gas, sewage etc.

Utmost care shall be taken to see that the width of the trench at the top of pipe is not more than the minimum requirement. In case additional width is required it shall be provided only in the top portion from the ground level upto 300 mm above the top of pipe. If any extra width is provided in the area below this portion, Contractor shall have to provide remedial measures in the form of lime concrete or rubble masonry otherwise at the discretion and to the satisfaction of the Engineer. If rock is met with, it shall be removed to 15 cm below the bottom of pipes and fittings/specials and the space resulting shall be refilled with granular materials and properly consolidated. Bottom of trenches/pits shall be saturated with water well rammed wherever the Engineer may consider it necessary to do so.

Wherever a socket or collar of pipe or fitting/ special occurs, a grip is to be cut in the bottom of the trench or concrete bed to a depth of at least 75 mm below the bed of the pipe so that the pipe may have a fair bearing on its shaft and does not rest upon its socket. Such grip shall be of sufficient size in every respect to admit the hand all around the socket in order to make the joint and the grip shall be maintained clear until the joint has been approved by the Engineer.

When welding is to be carried out with the pipes and specials in the trench, additional excavation of not more than 60cm in depth and 90 cm in length shall be made at joints in order to facilitate welding.

The excess excavated material shall be carried away from site of works to a place up to a distance as directed by the Engineer. This shall be done immediately so as not to cause any inconvenience to the public or traffic. If the instructions from Engineer are not implemented within seven days from the date of instructions to cart the materials and to clear the site, the same shall be carried out by the Engineer and any claim or dispute shall not be entertained in this respect.

(B) Dewatering

During the excavation, if subsoil water is met with Contractor shall provide necessary equipment and labourers for dewatering the trenches. The Contractor shall also make necessary arrangement for the disposal of drained water to nearby storm water drain or in a pit if allowed by the Engineer. In no case the water shall be allowed to spread over the adjoining area. Before discharging this water into public sewer/drain, the Contractor shall take necessary permission from the local authorities.

(C) Special Foundation in Poor Soil

Where the bottom of the trench and sub grade is found to consist of material which is unstable to such a degree that in the opinion of the Engineer, it cannot be removed and replaced with an approved material thoroughly compacted in place to support the pipe properly, a suitable foundation for the

pipes, consisting of piling, timbers or other materials, in accordance with relevant drawings to be prepared by the Contractor and as instructed by the Engineer shall be constructed.

(D) Wooden Shoring

Contractor shall suitably design polling boards, waling and struts to meet different soil conditions that might be encountered in excavating trenches/pits. The horizontal and vertical spacing of struts shall be such that not only the sides of trenches shall be prevented from collapse but also easy lowering of pipe in trenches shall be ensured without creating undue obstructions for the excavation of the work. Any inconvenience and/or delay that might be caused in lowering pipes in trenches as a result of adopting improper spacing of struts by Contractor shall be his sole responsibility. No part of shoring shall at any time be removed by Contractor without obtaining permission from the Engineer. While taking out shoring planks the hollows of any form must simultaneously be filled in with soft earth well rammed with rammers and with water.

The Engineer may order portions of shoring to be left in the trenches /pits at such places, where it is found absolutely necessary to do so to avoid any damage which may be caused to buildings, cables, gas mains, water mains, sewers etc. in close proximity of the excavation, by pulling out the shoring from the excavations. The Contractor shall not claim, on any reason whatsoever, for the shoring which may have been left in by him at his own discretion.

(E) Steel Plate Shoring

Where the subsoil conditions are expected to be of a soft and unstable character in trench/pit excavation, the normal method of timbering may prove insufficient to avoid subsidence of the adjoining road surfaces and other services. In such circumstances, the Contractor will be required to use steel trench sheeting or sheet piling adequately supported by timber struts, waling etc., as per the instructions, manner and method directed by the Engineer. Contractor shall supply pitch, drive and subsequently remove trench sheeting or piling in accordance with other items of the Employer's Requirements.

(F) Boning Staves and Sight Rails

In laying the pipes and fittings/ specials the centre for each manhole / chamber or pipeline shall be marked by a peg. Contractor shall dig holes for and set up two posts (about 100 x 100 x 1800 mm) at each manhole/chamber or junction of pipelines at nearly equal distance from the peg and at sufficient distances there from to be well clear of all intended excavation, so arranged that a sight rail when fixed at a certain level against the post shall cross the centre line of the manhole/chamber or pipe lines. The sight rail shall not in any case be more than 30 m apart; intermediate rails shall be put up if directed by the Engineer.

Boning staves of 75 mm x 50 mm size shall be prepared by Contractor in various lengths, each length being of a certain whole number of meters and with a fixed tee head and fixed intermediate cross pieces, each about 300 mm long. The top-edge of the cross piece must be fixed below the top-edge of the tee-head at a distance equal to the outside diameter of the pipe or the thickness of the concrete bed to be laid as the case may be. The top of cross pieces shall indicate different levels such as excavation for pipe line, top of concrete bed, top of the pipe etc. as the case may be.

The sight rail of size 250 mm x 40 mm shall be screwed with the top edge resting against the level marks. The center line of the pipe shall be marked on the rail and this mark shall denote also the meeting point of the center lines of any converging pipes. A line drawn from the top edge of one rail to the top edge of the next rail shall be vertically parallel with the bed of the pipe, and the depth of the bed of pipe at any intermediate point may be determined by letting down the selected boning staff until the tee head comes in the line of sight from rail to rail.

The post and rails shall be perfectly square and planed smooth on all sides and edges. The rails shall be painted white on both sides, and the tee-heads and cross-piece of the boning staves shall be painted black.

For the pipes converging to a manhole/chamber at various levels, there shall be a rail fixed for every different level. When a rail comes within 0.60 M of the surface of the ground, a higher sight-rail shall be fixed for use with the rail over the next point.

The posts and rails shall in no case be removed until the trench is excavated, the pipes are laid and the Engineer gives permission to proceed with the backfilling.

(G) Laying of Pipes and Fittings/Specials

All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure/pipeline of water, gas, sewage etc. After excavation of trenches, pipes shall not be lowered unless the dimensions of trenches and bedding work for pipes at the bottom of the trenches are approved and measured by Employer /Engineer. Pipes and fittings/specials shall be carefully lowered in the trenches. Special arrangements such as cranes, tripods with chain pulley block for lowering the pipes and fittings/specials shall be made by Contractor. In no case pipes and fittings/specials shall be dropped. Slings of canvas or equally non-abrasive material of suitable width or special attachment to fit the ends of pipes and fittings/specials shall be used to lift and lower the coated pipes and fittings/specials. The pipes and fittings /specials shall be inspected for defects and be rung with a light hammer preferably while suspended to detect cracks. If doubt persists, further confirmation shall be done by pouring a little kerosene/dye on the inside of the pipe at the suspected spot. No sign of kerosene/dye should appear on the outside surface. Pipes and fittings/specials damaged during lowering or aligning shall be rejected by the Engineer.

All the pipes are to be laid perfectly true both in alignment and to gradient specified. In case of spigot and socket pipe the socket end of the pipe shall face upstream, except when the pipeline runs uphill in which case the socket ends should face the upgrade. The laying of pipes shall always proceed upgrade of a slope. After placing a pipe in the trench, the spigot end shall be centered in the socket and the pipe forced home and aligned to required gradient. The pipes shall be secured in place with approved backfill material tamped under it except at the socket. Pipes and fittings/specials which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipes and fittings/specials of proper dimensions to ensure such uniform space. Precautions shall be taken to prevent dirt from entering the jointing space. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Engineer. During the period that the plug is on, the

Contractor shall take proper precautions against floating of the pipe owing to entry of water into the trench. Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or where long radius curves are permitted the deflection allowed at joints shall not exceed 2 ½0. In case of pipes, with joint to be made with loose collars, the collars shall be slipped on before the next pipe is laid. The pipes shall be laid such that the marking on pipes appears at the top of the pipes.

The cutting of pipe for inserting valves, fittings, or specials shall be done in a neat and workman like manner without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. For this purpose, pipe cutting machine shall be used.

(H) Thrust Blocks

Thrust Blocks shall be provided for all piping works, to counteract hydraulic thrust, at places wherever directed by the Engineer as per approved design.

(I) Jointing

Jointing for pipes and fittings/specials shall be done in accordance with the relevant Employer's Requirements depending upon the type of pipes being used.

(J) Testing and Commissioning

Testing and commissioning of pipes shall be done in accordance with the relevant Employer's Requirements.

(K) Backfilling

Trenches shall be backfilled with approved selected excavated material only after the successful testing of the pipeline. The tamping around the pipe shall be done by hand or other hand-operated mechanical means. The water content of the soil shall be as near the optimum moisture content as possible. Filling of the trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressure does not occur. Backfilling shall be done in layers not exceeding 30 cm. Each layer shall be consolidated by watering, ramming, care bring taken to avoid damage to the pipeline. In case of the mild steel pipes/specials, the spiders provided during assembly and welding shall be retained until the trench is refilled and consolidated. Where timbers are placed under the pipeline to aid alignment, these timbers shall be removed before backfilling.

The Contractor is requested to provide the method of Backfilling compaction test and evaluation value and obtain the approval from the Engineer.

(L) Reinstatement of Road/Footpath

Reinstatement of road/footpath shall be done as per the requirements of local authorities and the Employer's Requirements after completion of work.

(M) Clearing of Site

All surplus materials, and all tools and temporary structures shall be removed from the site as directed by the Engineer and the construction site left clean to the satisfaction of the Engineer.

End of Part 8

PART 10

Civil, Structural and Sewer Network Requirements

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CHAPTER 1

SITE CLEARANCE (CLEARING AND GRUBBING)

CHAPTER 1

SITE CLEARANCE (CLEARING AND GRUBBING)

1.1 Scope

This work shall consist of cutting, removing and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, top organic soil not exceeding 150 mm in thickness, rubbish etc., from the area of works which in the opinion of the Engineer are unsuitable for incorporation in the works, and such areas as may be specified on the drawings or by the Engineer. It shall include necessary excavation, backfilling of pits resulting from uprooting of trees and stumps to required compaction, handling, salvaging, and disposal of cleared materials. Clearing and grubbing shall be performed in advance of earthwork operations and in accordance with the requirements of these specifications.

1.2 Preservation of Property/Amenities

Trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, sewers and all facilities within or adjacent to the site which are not to be disturbed shall be protected from injury or damage. The Contractor shall provide and install at his own expense, suitable safeguards approved by the Engineer for this purpose.

During clearing and grubbing, the Contractor shall take all necessary precautions to prevent soil erosion, water pollution, and other environmental impacts, and where required, undertake additional works to mitigate these effects, as specified in the relevant Clauses of Chapter 3. Before the start of operations, the Contractor shall submit to the Engineer for approval his work plan, including the procedure to be followed for disposal of waste materials, etc., and the schedules for carrying out temporary and permanent erosion control works as stipulated in Chapter 3.

1.3 Methods, Tools and Equipment

Only such methods, tools and equipment as are approved by the Engineer and which will not affect the property to be preserved shall be adopted for the Work. If the area has thick vegetation / roots / trees, a crawler or pneumatic-tyred dozer of adequate capacity may be used for clearance purposes. The dozer shall have ripper attachments for removal of tree stumps. All trees, stumps, etc., falling within excavation and fill lines shall be cut to such depth below ground level that in no case these fall within 500 mm of the subgrade / foundation / bed level. Also, all vegetation such as roots, under-growths, grass and other deleterious matter unsuitable for incorporation in the Work shall be removed between fill lines to the satisfaction of the Engineer. On the areas beyond these limits, trees and stumps required to be removed as directed by the Engineer shall be cut down to 1 m below ground level so that these do not present any unsightly appearance.

All branches of trees extending above the roadway shall be trimmed as directed by the Engineer.

All excavations below the general ground level resulting from the removal of trees, stumps, etc., shall be filled with suitable material and compacted thoroughly to ensure the surface at these points conforms to the surrounding area.
Ant-hills both above and below ground, which are liable to collapse and obstruct free subsoil water flow, shall be removed. Their workings, which may extend several meters, shall be suitably treated.

1.4 Disposal of Materials

All materials arising from clearing and grubbing operations shall be the property of Employer and shall be disposed of by the Contractor as directed by the Engineer.

Trunks and stumps of trees shall be cleaned of limbs and roots and stacked. Also boulders, stones and other materials usable in construction shall be neatly stacked as directed by the Engineer. Stacking stumps, boulders, stones etc., shall be done at specified spots with all lifts and lead.

All products of clearing and grubbing which, in the opinion of the Engineer, cannot be used or auctioned shall be cleared away from the site in a manner as directed by the Engineer. Care shall be taken to see that unsuitable waste materials are disposed off in such a manner that there is no likelihood of these getting mixed up with the materials meant for construction.

1.5 Measurements for Payment

Clearing and grubbing shall be measured on area basis in terms of hectares. Clearing and grubbing of borrow areas shall be deemed to be a part of Works preparatory to embankment construction and shall be deemed to have been included in the rates quoted for the embankment construction item and no separate payment shall be made for the same. Cutting of trees up to 300 mm in girth including removal of stumps and roots, and trimming of branches of trees extending above the roadway shall be considered incidental to the clearing and grubbing operations. Removal of stumps left over after trees have been cut by any other agency shall also be considered incidental to the clearing and grubbing operations.

Cutting, including removal of stumps and roots of trees of girth above 300 mm and backfilling to required compaction shall be measured in terms of number according to the sizes given below:

Above 300 mm to 600 mm;
Above 600 mm to 900 mm;
Above 900 mm to 1800 mm; and
Above 1800 mm.

For this purpose, the girth shall be measured at a height of 1 m above ground or at the top of the stump if the height of the stump is less than 1 m from the ground.

1.6 Rates

The Contract unit rates for the various items of clearing and grubbing shall be payment in full for carrying out the required operations, including full compensation for all labour, materials, tools, equipment, and incidentals necessary to complete the work. These will also include the removal of stumps of trees with a girth of less than 300 mm, as well as stumps left over after trees are cut by another agency. Additionally, this will involve excavation and backfilling to the required density, where necessary, and handling, salvaging, piling, and disposing of the cleared materials, including all lifts and leads.

The Contract unit rates for cutting (including removal of stumps and roots) of trees of girth above 300 mm shall include excavation and back-filling to required compaction, handling, salvaging, piling and disposing of the cleared materials with all lifts and lead.

Where a Contract does not include separate items of clearing and grubbing, the same shall be considered incidental to the earthwork items and the Contract unit prices for the same shall be considered as including clearing and grubbing operations.

End of Chapter-1

CHAPTER 2

DISMANTLING AND DEMOLITION

CHAPTER 2

DISMANTLING AND DEMOLITION

2.1 Scope

This work shall consist of removing, as hereinafter set forth, existing buildings, roofs, ceiling, flooring and paving, concrete and brick roofs and suspended floors, walls and columns, reinforced concrete and brick work, partitions, wood work, steel and iron work, doors and windows, pipes and sewer lines, posts or struts, fencing wire mesh, glazing, culverts, bridges, pavements, kerbs and other structures like guard-rails, utility services, catch basins, inlets, etc., which are in place but interfere with the new construction or are not suitable to remain in place, and of salvaging and disposing of the resulting materials and back filling the resulting trenches and pits.

Existing culverts, bridges, pavements, and other structures that are within the highway and that are designated for removal shall be removed up to the limits and extent specified in the Drawings or as indicated by the Engineer.

Dismantling and removal operations shall be carried out using suitable equipment and in a manner that leaves the adjacent pavement, structures, and any other work to be left in place undisturbed.

All operations necessary for the removal of any existing structure which might endanger new construction shall be completed prior to the start of new work.

2.2 Applicable Codes

IS: 1200-1974 (Part: XVIII)	Method of Measurements of Building and Civil Engineering Works - Demolition and Dismantling (Reaffirmed 2002) (3rd Revision).
IS: 4130-1991	Demolition of Buildings - Code of Safety (2nd Revision).

2.3 Terminology

The term ‘Dismantling’ implies carefully separating the parts without damage and removing. This may consist of dismantling one or more parts of the structure as specified.

The term ‘Demolition’ implies breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified.

2.4 Buildings

2.4.1 Precautions

All materials obtained from dismantling or demolition shall be the property of the Employer unless otherwise specified and shall be kept in safe custody until they are handed over to the Engineer.

Demolition shall always be well-planned beforehand and generally be done in the reverse order in which the structure was constructed. The Engineer-In-Charge shall approve the operations before starting the work.

Due care shall be taken to maintain the safety measures prescribed in IS: 4130.

Necessary propping, shoring, and/or underpinning shall be provided to ensure the safety of the adjoining work or property before dismantling and demolition is undertaken, and the work shall be carried out in such a way that no damage is caused to the adjoining work or property. Wherever specified, temporary enclosures or partitions shall also be provided, as directed by the Engineer.

Necessary precautions shall be taken to minimize the dust nuisance.

Dismantling shall be done in a systematic manner. All materials which are likely to be damaged by dropping from a height or by demolishing roofs, masonry, etc., shall be carefully removed first. The dismantled articles shall be removed manually or otherwise, lowered to the ground (and not thrown) and then properly stacked as directed by the Engineer.

Where existing fixing is done by nails, screws, bolts, rivets, etc., dismantling shall be done by taking out the fixing with proper tools and not by tearing or ripping off.

Any serviceable material, obtained during dismantling or demolition, shall be separated out and stacked properly as directed by the Engineer within a lead of 50 m. All unserviceable materials rubbish etc. shall be disposed off as directed by the Engineer.

The Contractor shall maintain / disconnect existing services, whether temporary or permanent, where required by the Engineer.

2.4.2 Measurements

All work shall be measured net in the decimal system, as fixed in its place, subject to the following limits, unless otherwise stated hereinafter.

1. Dimensions shall be measured correct to a cm.
2. Areas shall be worked out in sq mt correct to two places of decimal.
3. Cubical contents shall be worked out to the nearest 0.01 cum.

Parts of the work that require dismantling and those that require demolition shall be measured separately.

Measurements of all works except hidden work shall be taken before demolition or dismantling and no allowance for increase in bulk shall be allowed.

Specifications for deduction for voids, openings etc. shall be on the same basis as that adopted for new construction of the work.
Work executed in the following conditions shall be measured separately:

1. Work in or under water and / or liquid mud;
2. Work in or under foul position.

2.4.3 Rates

The rate shall include the cost of all labour involved and tools used in demolishing and dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing off unserviceable material within a distance of 50 m.

The rate shall also include for temporary shoring for the safety of portions not required to be pulled down, or of adjoining property, and providing temporary enclosures or partitions, where considered necessary.

2.5 Roofs

Roof coverings generally including battens boarding, mats, bamboo jaffari or other subsidiary supports shall be measured in sq mt except lead sheet roof covering, which shall be measured in tonnes and stone slab roof covering which shall be measured in cum.

Ridges, hips and valleys shall be girthed and included with the roof area. Corrugated or semi corrugated surfaces shall be measured flat and not girthed.

Mud phuska on roofs shall be measured in cum.

Lead sheets in roofs shall be measured in tonnes and hips, valleys, flashings, lining to gutter etc. shall be included in this weight.

R.B. or R.C.C. roofs shall be measured in cum and if reinforcement is required to be salvaged, it shall be so stated. When reinforcement is required to be separated, scraped and cleaned, the work shall be measured separately as tonnes of salvaged steel.
Supporting members, such as rafters, purlins, beams joists, trusses etc. where of wood shall be measured in cum and steel or iron sections in tonnes.

2.6 Ceiling

The stripping of ceilings shall be measured in sqm.

Dismantling of supporting joists, beams, etc. shall be measured in cum or in tonnes.

Height above floor levels if it exceeds 3.5 m shall paid for separately.

2.7 Flooring and Paving

Dismantling of floors (except concrete and brick floors) shall be measured in sqm. Supports such as joints, beams etc. if any shall be measured as per Clause 2.5. Concrete and bricks paving shall be measured as per Clause 2.8.

2.8 Concrete and Brick Roofs and Suspended Floors

Demolition of floors and roofs of concrete or brick shall be measured in cum. Beams cantilevers or other subsidiary supports of similar materials shall be included in the item. In measuring thickness of roofs provided with water proofing treatments with bitumen, felts, the thickness of water proofing treatment shall be ignored.

2.9 Walls and Piers

Taking down walls and independent piers or columns of brick, stone or concrete shall be measured, in cum. All copings, corbels, cornices and other projections shall be included with the wall measurements.
In measuring thickness of plastered walls, the thickness of plaster shall be ignored.

Ashlar face stones, dressed stone work, precast concrete articles, etc. if required to be taken down intact shall be so stated, and measured separately in cum.

Cleaning bricks stacking for measurements including all extra handling and removal and disposing off the rubbish as stated shall be enumerated in thousand of cleaned bricks.

Cleaning stone obtained from demolished / dismantling stone masonry of any description including ashlar facing dressed stone work, stone slabs or flagging and precast concrete blocks including all extra handling and disposing of the rubbish as stated shall be measured in cum of cleaned stone.

Honey comb works or cavity walls of bricks stone or concrete shall be measured as solid.

2.10 Reinforced Concrete and Brick Work

Reinforced concrete structures and reinforced brick roof and walls shall be measured in cum and if reinforcement is required to be salvaged, it shall be so stated.

Where reinforcement is required to be separated, scraped and cleaned, the work shall be measured separately in tonnes of salvaged steel.

2.11 Partitions, Trellis Work, Etc.

Partitions or light walls of lath and plaster, trellis work, expanded metal, thin concrete or terracotta slabs and other similar materials including frame work if any shall be measured in sqm stating the overall thickness.

2.12 Wood Work

All wood work including karries average 40 sq cm or over in section, shall be measured in cum, while that under 40 sq cm in section, in running metres. Ballies shall be measured in running metres.
Boarding including wooden chajjas and sun shades along with supports shall be measured in square m in its plane.

2.13 Steel and Iron Work

All steel and iron work shall be measured in tonnes. The weight shall be computed from standard tables unless the actual weight can readily be determined.
Riveted work, where rivets are required to be cut, shall be measured separately.

Marking of structural steel required to be re-erected shall be measured separately.

In framed steel items, the weight or any covering material or filling such as iron sheets and expanded metal shall be included in the weight of the main article unless such covering is not ordered to be taken out separately.

2.14 Doors and Windows

Dismantling of doors, windows, clerestory windows, ventilators etc. (Wood or metal) whether done separately or along with removal of wall by making recess in the wall shall be enumerated. Those exceeding 3 sqm each in area shall be measured separately. The item shall include removal of chowkhats architraves, hold fasts and other attachments.

If only shutters are to be taken out it shall be measured separately.

2.15 Pipes and Sewer Lines

Water pipe lines including rain water pipes with clamps and specials, sewer lines (salt glazed ware or concrete) etc. shall be described by their diameter and length measured in running metre(RM) inclusive of joints.

If the joints, special and fittings etc. are required to be separated, it shall be so stated and enumerated.

Pucca drains shall be measured under relevant items.

Value cistern, public fountain platform, fire hydrants, etc. shall be enumerated.

Machine holes and inspection chambers shall be enumerated stating the size and depth of Machine hole/inspection chamber. They shall be classified into different groups depending upon the depth, in unit of half and one metre depth. The depth of the Machine hole shall be the distance between the top of Machine hole cover and invert level of the drain.

Ventilating shafts, gully traps, flushing cisterns and other appurtenant items of work shall be enumerated.

2.16 Posts or Struts

Posts or struts (wood, steel or RCC) section including taking out embedded portion shall be measured in running metre.

2.17 Fencing Wire Mesh

Wire mesh fencing of any type with frame shall be measured in square metre.

2.18 Glazing

Taking out any portion of serviceable glass except polished plate, from old sashes, skylights, etc. (any thickness, weight or size) raking out old putty, etc. shall be measured in square metre.

Irregular or circular panes shall be measured as rectangle or square enveloping the same, the width and height being measured correct to the nearest 0.5 cm.

2.19 Dismantling Culverts, Bridges and Other Structures/Pavements

2.19.1 Dismantling Culverts and Bridges

The structures shall be dismantled carefully and the resulting materials so removed as not to cause any damage to the serviceable materials to be salvaged, the part of the structure to be retained and any other properties or structures nearby.

Unless otherwise specified, the superstructure portion of culverts / bridges shall be entirely removed and other parts removed below the ground level or as necessary depending upon the interference they cause to the new construction. Removal of overlaying or adjacent material, if required in connection with the dismantling of the structures shall be incidental to this item.

Where existing culvert / bridges are to be extended or otherwise incorporated in the new work, only such part or parts of the exiting structure shall be removed as are necessary and directed by the Engineer to provide a proper connection to the new work. The connecting edges shall be cut, chipped and trimmed to the required lines and grades without weakening or damaging any part of the structure to be retained. Due care should be taken to ensure that reinforcing bars which are to be left in place to project into the new work as dowels or ties are not injured during removal of concrete.

Pipe culverts shall be carefully removed in such manner as to avoid damage to the pipes.

Steel structures shall, unless otherwise provided, be carefully dismantled in such a manner as to avoid damage to members thereof. If specified in the Drawings or directed by the Engineer that the structure is to be removed in a condition suitable for re-erection, all members shall be match-marked by the Contractor with white lead paint before dismantling; end pins, nuts, loose plates, etc., shall be similarly marked to indicate their proper location; all pins, pin holes and machined surfaces shall be painted with a mixture of white lead and tallow and all loose parts shall be securely wired to adjacent members or packed in boxes.
Timber structures shall be removed in such a manner as to avoid damage to such timber or lumber when designated by the Engineer to be salvaged.

2.19.2 Dismantling Pavements and Other Structures

In removing pavements, kerbs, gutters and other structures like guard-rails, fences, Machine holes, catch-basins, inlets, etc. where portions of the existing construction are to be left in the finished work, the same shall be removed to an existing joint or cut and chipped to a true line with a face perpendicular to the surface of the existing structure. Sufficient removal shall be made to provide for proper grades and connections with the new work as directed by the Engineer.

All concrete pavements, base courses in carriageway and shoulders etc., designated for removal shall broken to pieces whose volume shall not exceed 0.02 cum and stockpiled at designated locations if the material is to be used later or otherwise arranged for disposal as directed (see Clause 2.19.4).

2.19.3 Back-filling

Holes and depressions caused by dismantling operations shall be backfilled with excavated or other approved materials and compacted to required density as directed by the Engineer.

2.19.4 Disposal of Materials

All materials obtained by dismantling shall be the property of Employer. Unless otherwise specified, materials having any salvage value shall be placed in neat stacks of like materials within the right-of-way, as directed by the Engineer with all lifts and up to a lead of 1000 m.

Pipe culverts that are removed shall be cleaned and neatly piled on the right-of-way at points designated by the Engineer with all lifts and lead up to 1000 m.

Structural steel removed from old structures shall, unless otherwise specified or directed, be stored in a neat and presentable manner on blocks in locations suitable for loading. Structures or portions thereof which are specified in the Contract for re-erection shall be stored in separate piles.

Timber or lumber from old structures which is designated by the Engineer as materials to be salvaged shall have all nails and bolts removed there from and shall be stored in neat piles in locations suitable for loading.

All materials obtained from dismantling operations which, in the opinion of the Engineer, cannot be used or auctioned shall be disposed of as directed by the Engineer with all lifts and up to a lead of 1000 m.

2.19.5 Measurements for Payment

The work of dismantling structures shall be paid for in units indicated below by taking measurements before and after, as applicable:

1.	Dismantling brick/stone masonry/concrete (plain and reinforced)	cum.
2.	Dismantling flexible and cement concrete pavement	cum.
3.	Dismantling steel structures	tonne
4.	Dismantling timber structures	cum.
5.	Dismantling pipes, guard rails, kerbs, gutters and fencing	linear m.
6.	Utility services	Nos.

2.19.6 Rates

The Contract unit rates for the various items of dismantling shall be paid in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment, safeguards and incidentals necessary to complete the work. These will also include excavation and backfilling where necessary to the required compaction and for handling, salvaging, piling and disposing of the dismantled materials within all lifts and up to a lead of 1000 m.

End of Chapter-2

CHAPTER 3

EARTHWORKS

CHAPTER 3

EARTHWORKS

3.1 Applicable Codes

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to.

a) IS 783 - 1985 - (Reaffirmed 2017) Code of practice for laying of Concrete pipes.
IS 4984 - 1995 - (Reaffirmed 2016) Code of practice for laying of HDPE pipes.
IS 12288 - 1987 - (Reaffirmed 2017) Code of practice for use and laying of DI pipes.

b) IS 3764 - 1992 - (Reaffirmed 2017) Excavation work - Code of Safety.

c) IS 2720 - Methods of test for soils:
(Part-1) - 1983 - (Reaffirmed 2015) Preparation of dry soil samples for various tests.
(Part-2) - 1973 - (Reaffirmed 2015) Determination of Water Content.
(Part-4) - 1985 - (Reaffirmed 2015) Grain size analysis.
(Part-5) - 1985 - (Reaffirmed 2015) Determination of liquid and plastic limit.
(Part-7) - 1980 - (Reaffirmed 2016) Determination of water content - dry density relation using light compaction.
(Part-9) - 1992 - (Reaffirmed 2016) Determination of dry density - moisture content by constant weight of soil method.
(Part-14) - 1983 - (Reaffirmed 2015) Determination of density index (relative density) Cohesionless soils.
(Part-22) - 1972 - (Reaffirmed 2015) Determination of organic matter.
(Part-26) - 1987 - (Reaffirmed 2016) Determination of pH Value.
(Part-27) - 1977 - (Reaffirmed 2015) Determination of total soluble sulphates.
(Part-28) - 1974 - (Reaffirmed 2015) Determination of dry density of soils in place, by the sand replacement method.
(Part-33)-1971 - (Reaffirmed 2015) Determination of the density in place by the ring and water replacement method.

(Part-34) - 1972- (Reaffirmed 2015)	Determination of density of soil in place by rubber balloon method.
(Part-38) - 1976- (Reaffirmed 2016)	Compaction control test (Hilf Method).

3.2 Drawings

Engineer will furnish drawings wherever, in his opinion, such drawings are required to show areas to be excavated/filled grade level, sequence of priorities etc. Contractor shall strictly follow such drawings.

3.3 General

The Contractor shall furnish all tools, plant, instruments, qualified supervisory personnel, labour, materials, any temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein for completion of the work in accordance with the Specifications.

The Contractor shall survey the site before excavation and set out all lines and establish levels for various works such as grading, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference/grid lines at 8m intervals or nearer, if necessary, based on ground profile and thereafter properly recorded.

The excavation shall be carried out to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night.

The rates quoted shall also include for dumping of excavated material in regular heaps, bunds, riprap with regular slopes within the lead specified and levelling the same so as to provide natural drainage. Rock/soil excavated shall be stacked properly as approved by the Engineer. As a rule, all softer material shall be laid along the center of heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.

Topsoil shall be stock piled separately for later re-use.

3.4 Clearing

The area to be excavated/filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush, etc. and other objectionable matter. If any roots or stumps of trees are encountered during excavation, they shall also be removed. The material so removed shall be disposed off as approved by the Engineer. Where earth fill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter/ materials before fill commences.

3.5 Classification

All materials to be excavated shall be classified by Engineer, into one of the following classes and shall be paid for at the rate tendered for that particular class of material. No distinction shall be made whether the material is dry, moist or wet. The decision of Engineer regarding the classification of the material shall be final and binding on Contractor and not be a subject matter of any appeal or arbitration.

Any earthwork will be classified under any of the following categories:

a) Ordinary & Hard Soils

These shall include all kinds of soils containing kankar, sand, silt, moorum and/or shingle, gravel, clay, loam, peat, ash, shale, etc., which can generally be excavated by spade, pick axes and shovel, and which is not classified under "soft and decomposed rock" and "hard rock" defined below. This shall also include embedded rock boulders not longer than 1 metre in any one direction and not more than 200 mm in any one of the other two directions.

b) Soft and Decomposed Rock

This shall include rock, boulders, slag, chalk, slate, hard mica schist, laterite, highly weathered granite gneiss and all other materials which in the opinion of Engineer is rock, but does not need blasting and could be removed readily with picks, hammer, crow bars, wedges, and pneumatic breaking equipment. The mere fact that Contractor resorts to blasting for reasons of his own, shall not qualify for classification under 'hard rock'.

This shall also include excavation in macadam and tarred roads and pavements. This shall also include rock boulders not longer than 1 metre in any direction and not more than 500 mm in any one of the other two directions. Masonry to be dismantled will also be measured under this item.

c) Hard Rock

This shall include all rock occurring in large continuous masses which cannot be removed except by blasting, chiselling or by drilling with heavy mechanical breakers. Harder varieties of rock with or without veins and secondary minerals which, in the opinion of Engineer require blasting shall be considered as hard rock. Boulders of rock occurring in such sizes and not classified under (a) and (b) above shall also be classified as hard rock. Concrete work both reinforced and unreinforced to be dismantled will be measured under this item, unless a separate provision is made in the Schedule of Quantities.

Before classification of material as rock the Contractor shall demonstrate to the satisfaction of the Employer's Representative his inability to excavate it without resort to heavy percussion tools complete with rock bits, hydraulic wedges or blasting. Excavation by the use of explosive will not normally be permitted.

Material shall not be classified as rock unless the Employer's Representative has agreed to such classification on the basis of such a demonstration before its excavation. Excavations where rock has been encountered and classified as such shall not be backfilled before

examination of the excavated faces by the Employer's Representative to enable the extent of the rock excavation to be determined.

3.6 Excavation

All excavation work shall be carried out by mechanical equipment unless, in the opinion of Engineer, the work involved requires it to be carried out by manual methods.

Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the drawings provided by the Contractor or such other lines and grades as may be agreed with the Engineer. Rough excavation shall be carried out to a depth of 150mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed below the final level and extra excavation filled up with lean concrete of grade M10 with 20 mm downgraded aggregates as approved by the Engineer. The final excavation should be carried out just prior to laying the blinding course.

Contractor may, for facility of work or similar other reasons excavate, and also backfill later, if so approved by Engineer, at his own cost outside the lines shown on the drawings or directed by Engineer. Should any excavation be taken below the specified elevations, Contractor shall fill it up, with concrete of the same class as in the foundation resting thereon, upto the required elevation. No extra shall be claimed by Contractor on this account.

All excavations shall be to the minimum dimensions required for safety and ease of working. Prior approval of the Engineer shall be obtained by the Contractor in each individual case, for the method proposed for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope. Removal of the slipped earth will not be paid for if the slips are due to the negligence of Contractor.

3.7 Stripping Loose Rock

All loose boulders, detached rocks partially and other loose material which might move therewith not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of Engineer, to fall or otherwise endanger the workmen, equipment, or the work shall be stripped off and removed from the area of the excavation. The method used shall be such as not to render unstable or unsafe the portion which was originally sound and safe.

Any material not requiring removal in order to complete the permanent works, but which, in the opinion of Engineer, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed. The cost of such stripping will be paid for at the unit rates accepted for the class of materials in question.

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3.8 Excavation in Hard Rock

3.8.1 General Requirements

Unless otherwise stated herein, I.S Specification "IS- 4081(1986) Safety code for Blasting and related Drilling Operations" shall be followed. After removal of overburden, if any, excavation shall be continued in rock to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Engineer. As far as possible all blasting shall be completed prior to commencement of construction. At all stages of excavation, precautions shall be taken to preserve the rock below and beyond the lines specified for the excavation, in the soundest possible condition. The quantity and strength of explosive used shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by the Engineer, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structure as a result of blasting operations. In case of damage to permanent or temporary structures, Contractor shall repair the same to the satisfaction of the Engineer at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

Specific permission of the Engineer will have to be taken by Contractor for blasting rock and he shall also obtain a valid Blasting License from the authorities concerned. If permission for blasting is refused by the Engineer, the rock shall be removed by wedging, pick, barring, heating and quenching or other approved means. All loose or loosened rock in the sides shall be removed by barring, wedging, etc. The unit rate for excavation in hard rock shall include the cost of all these operations.

Contractor shall obtain necessary license for storage of explosives, fuses and detonators issued to him from Employer's stores or from supplier arranged by him, from the authorities dealing with explosives. The fees, if any, required for obtaining such license, shall be borne by Contractor. Contractor shall have to make necessary storage facilities for the explosives etc. as per rules of local, State and Central Government authorities and Statutory bodies/regulations. Explosives shall be kept dry and shall not be exposed to direct rays of sun or be stored in the vicinity of fire, stoves, steam pipes or heated metal, etc. No explosive shall be brought near the work in excess of quantity required for a particular amount of firing to be done; and surplus left after filling the holes shall be removed to the magazine. The magazine shall be built as for as possible away from the area to be blasted, Engineer's prior approval shall be taken for the location proposed for the magazine.

In no case shall blasting be allowed closer than 30 metres to any structure or to locations where concrete has just been placed. In the latter case the concrete must be at least 7 days old.

Excavation in hard rock shall be only by chiseling / Jack hammering or by drilling with mechanical breakers.

The rock shall be removed by wedging, pick, boring, heating and quenching or other approved non-blasting methods. All loose or loosened rock in the sides shall be removed by barring, wedging etc. The unit rate for excavation in hard rock shall include the cost of all these operations. No blasting is allowed.

3.8.2 Specific Requirements

For blasting operations, the following points shall be observed.

Contractor shall employ a competent and experienced supervisor and licensed blaster in-charge of each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.

Before any blasting is carried out, Contractor shall intimate Engineer and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.

Contractor shall ensure that all workmen and the personnel at site are excluded from a area within 200 m. radius from the firing point, at least 5 minutes before firing time by sounding warning whistle. The area shall also be given warning by sounding a distinguishing whistle.

The blasting of rock near any existing buildings, equipment or any other property shall be done under cover if permitted by the Engineer and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done by M.S. plates with adequate dead weight over them. Blasting shall be done with small charges only and where directed by Engineer, a trench shall have to be cut by chiseling prior to the blasting operation separating the area under blasting from the existing structures.

The firing shall be supervised by a Supervisor and not more than 6 (six) holes at a time shall be set off successively. If the blasts do not tally with the number fired, the misfired holes shall be carefully located after half an hour and when located, shall be exploded by drilling a fresh hole along the misfired hole (but not nearer than 600 mm from it) and by exploding a new charge.

A wooden tamping rod with a flat end shall be used to push cartridges home and metal rod or hammer shall not be permitted. The charges shall be placed firmly into place and not rammed or pounded. After a hole is filled to the required depth, the balance of the hole shall be filled with stemming which may consist of sand or stone dust or similar inert material.

Contractor shall preferably detonate the explosives electrically.

The explosives shall be exploded by means of a primer which shall be fired by detonating a fuse instantaneous detonator (F.I.D) or other approved cables. The detonators with F.I.D shall be connected by special nippers.

In dry weather and normal dry excavation, ordinary low explosive gunpowder may be used. In damp rock, high explosive like gelatine with detonator and fuse wire may be used. Under or for excavation in rock with substantial accumulated seepage electric detonation shall be used.

Holes for charging explosive shall be drilled with pneumatic drills, the drilling pattern being so planned that rock pieces after blasting will be suitable for handling without secondary blasting.

When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond an overbreak limit of 75 mm shall be filled up as instructed by Engineer, with concrete of strength not less than M10. The cost of filling such excess depth shall be borne by Contractor and the excavation carried out beyond the limit specified above will not be paid for. Stopping in rock excavation shall be done by hand trimming.

Contractor shall be responsible for any accident to workmen, public or Employer's property due to blasting operations. Contractor shall also be responsible for strict observance of rules, laid by Inspector of Explosives, or any other Authority duly constituted under the State and /or Union Government.

3.9 Fill, Backfilling and Site Grading

3.9.1 General

All fill material shall be subject to the Engineer's approval. If any material is rejected by Engineer, the Contractor shall remove the same forthwith from the site. Surplus fill material shall be deposited/disposed off as directed by Engineer after the fill work is completed.

No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with to the approval of the Engineer.

The Contractor shall not commence the placement of any fill or backfill at any location without the approval of the Engineer.

3.9.2 Material

To the extent available, selected surplus soils from excavations shall be used as backfill. Backfill material shall be free from lumps, organic or other foreign material. All lumps of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murum or earth to fill the voids and the mixture used for filling.

If fill material is required to be imported, the Contractor shall make arrangements to bring such material from outside borrow pits. The material and source shall be subject to the prior approval of the Engineer. The approved borrow pit areas shall be cleared of all bushes, roots of trees, plants, rubbish, etc. Top soil containing foreign material shall be removed. The materials so removed shall be disposed off as directed by Engineer. The Contractor shall provide the necessary access roads to borrow areas and maintain the same if such roads do not exist, at his cost.

3.9.3 Filling in pits and trenches around foundations of structures, walls, etc.

As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches, etc., shall be cleared of all debris and filled with earth in layers not exceeding 15 cm, each layer being watered, rammed and properly consolidated, before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of

Engineer. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction shall be allowed unless the Engineer is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and leveled to a proper profile to the approval of the Engineer.

3.9.4 Plinth Filling

Plinth filling shall be carried out with approved material as described hereinbefore in layers not exceeding 15cm, watered and compacted with mechanical compaction machines. The Engineer may, however, permit manual compaction by hand tampers where he is satisfied that mechanical compaction is not possible. When filling reaches the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours, allowed to dry and then the surface again compacted as specified above to avoid settlement at a later stage. The finished level of the filling shall be trimmed to the level/slope specified.

Compaction of the plinth fill shall be carried out by means of 12 ton rollers smooth wheeled, sheep-foot or wobbly wheeled rollers. In case of compaction of granular material such as sands and gravel, vibratory rollers shall be used. A smaller weight roller may be used only if permitted by the Engineer. As rolling proceeds, water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fills.

The thickness of each unconsolidated fill layer can in this case be upto a maximum of 300mm. The Contractor will determine the thickness of the layers in which fill has to be consolidated depending on the fill material and equipment used and the approval of the Engineer obtained prior to commencing filling.

Rolling shall commence from the outer edge and progress towards the centre and continue until compaction is to the satisfaction of Engineer, but in no case less than 10 passes of the roller will be accepted for each layer.

The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated, then filled and consolidated.

At some locations/areas, it may not be possible to use rollers because of space restrictions, etc. The Contractor shall then be permitted to use pneumatic tampers, rammers, etc. and he shall ensure proper compaction.

3.9.5 Sand Filling in Plinth and Other Places

Where backfilling is required to be carried out with local sand it shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded condition shall be on Contractor’s account. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floors or other structures on sand fill shall not be started until the Engineer has inspected and approved the fill.

3.9.6 Filling in Trenches

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. The backfilling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the pipes.

Where the trenches are excavated in soil, the filling from the bottom of the trench to the level of the centre line of the pipe shall be done by hand compaction with selected approved earth in layers not exceeding 8 cm; backfilling above the level of the centre line of the pipes shall be done with selected earth by hand compaction, or other approved means in layers not exceeding 15 cm.

In case of excavation of trenches in rock, the filling upto a level 30 cm above the top of the pipe shall be done with fine materials such as earth, murum, etc. The filling up to the level of the centre line of the pipe shall be done by hand compaction in layers not exceeding 8 cm whereas the filling above the centre line of the pipe shall be done by hand compaction or approved means in layers not exceeding 15 cm. The filling from a level 30 cm above the top of the pipe to the top of the trench shall be done by hand or other approved mechanical methods with broken rock filling of size not exceeding 15 cm mixed with fine material as available to fill up the voids.

Filling of the trenches shall be carried out simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

In the case of water transmission, pipe lines works etc for water transfer, the Contractor shall take proper precautions against the risks of floatation. Should any section of the pipeline be affected by floatation in the course of works the entire work shall be removed and then reinstalled to the satisfaction of Engineer.

3.10 General Site Grading

Site grading shall be carried out as indicated in the drawings and as approved by the Engineer. Excavation shall be carried out as specified in the Specifications. Filling and compaction shall be carried out as specified under Clause 3.9 and elsewhere unless otherwise indicated below.

The fill has to be compacted in layers not exceeding 225 mm and leveled uniformly and compacted as indicated in Clause 3.9 before the next layer is deposited.

To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the Contractor at his cost.

Field compaction tests shall be carried out in each layer of filling until the fill to the entire height has been completed. This shall hold good for embankments as well. The fill will be considered as incomplete if the desired compaction has not been obtained.

The Contractor shall protect the earth fill from being washed away by rain or damaged in any other way. Should any slip occur, the Contractor shall remove the affected material and make good the slip at his cost.

If so specified, the rock as obtained from excavation may be used for filling and leveling to indicate grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 ton roller. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

3.11 Fill Density

The compaction, where so called for, shall comply with minimum 95% Modified Proctor density at moisture content differing not more than 4% from the optimum moisture content. The Contractor shall demonstrate adequately by field and laboratory tests that the specified density has been obtained.

3.12 Lead

Lead for deposition/disposal of excavated material, shall be as specified in the respective item of work. No extra compensation is admissible on the grounds that the lead including that for borrowed material had to be transported over marshy or 'katcha' land/route.

3.13 Measurement and Payment

All excavation shall be measured net. Dimensions for purpose of payment shall be reckoned on the horizontal area of the excavation at the base for foundations of the walls, columns, footings, tanks, rafts or other foundations/structures to be built, multiplied by the mean depth from the surface of the ground in accordance with the drawings. Excavations in side slopes will not be paid for. Contractor may make such allowance in his rates to provide for excavation in side slopes keeping in mind the nature of the soil and safety or excavation. Reasonable working space, beyond concrete dimensions and shuttering where considered necessary in the opinion of Engineer will be allowed in excavation and considered for payment. However, if concreting is proposed against the excavated sides, no such over-excavation will be permitted. In such cases over-excavation shall be made good by Contractor with concrete of the same class as in the foundations at his cost.

In the case of water transmission, pipelines works etc for water transfer trench excavation shall be measured using the dimensions detailed in the standard section shown on the Drawings. No payment will be made for working space except where clearly mentioned on the drawings. Excavation beyond the widths or depths required will not be paid for any additional concrete or bedding material required as a result of over-excavation at the Contractor's expense.

Backfilling as per specification the sides of foundations of columns, footings, structures, walls, tanks, rafts, trenches etc. with excavated material will not be paid for separately. It shall be clearly understood that the rate quoted for excavation including backfilling shall include stacking of excavated material as directed, excavation/packing of selected stacked material, conveying it to the place of final backfill, compaction etc. as specified. As a rule, material to be backfilled shall be stacked temporarily within the site as directed by the Engineer

Payment for fill inside trenches, plinth or similar filling with selected excavated material will be made for only compaction as specified/directed. Cost of all other operations shall be deemed to have been covered in the rate quoted for excavation. Payment for this work will be made based on measurement of plinth/trench dimensions as per drawings. The plinth ground levels shall be surveyed beforehand for this purpose. If no compaction is specified/desired such filling will not be separately paid for. In such an event the fill shall be leveled/finished to the profile as directed at no extra cost.

Backfilling, plinth filling etc. with borrowed earth will be paid for at rates quoted. The quoted rate shall include all operations such as clearing, excavation, lead and transport, fill, compaction etc, as specified. Actual quantity of consolidated filling or actual quantity or excavation in the borrow pits (less such top soil which has been excavated and not used for filling) whichever is less shall be measured and paid for in cubic meters. The lead, lift etc. shall be as indicated in the schedule of quantities.

Actual quantity of consolidated sand filling shall be measured and paid in cubic meters.

Volume of rock excavated shall be calculated on the basis of length, breadth and depth of excavation indicated on the drawings. No payment will be made for excavations/over break beyond payment line specified. Where such measurement is not possible as in the case of strata intermixed with soil, excavated rock shall be properly stacked as directed by Engineer and the volume of rock calculated on the basis of stack measurements after making appropriate allowance for voids. The allowance to be made for voids shall be decided by Engineer and this will not be a subject matter of dispute or appeal.

3.14 Timber Shoring

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 25 cm x 4 cm sections or as approved by the Engineer. The boards shall generally be placed in position vertically side by side without any gap on each side of the excavation and shall be secured by horizontal walling of strong wood at maximum 1.2 meter spacing's, strutted with ballies or as approved by the Engineer. The length of the ballie struts shall depend on the width of the trench or pit. If the soil is very soft and loose, the boards shall be placed horizontally against each side of the excavation and supported by vertical walling, which in turn shall be suitably strutted. The lowest boards supporting the sides shall be taken into the ground and no portion of the vertical side of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

Timber shoring shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench. The type of timbering shall be as approved by the Engineer. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of excavations, trenches, pits, etc. from collapsing.

Timber shoring may also be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons. Such shoring shall be carried out, except in an emergency, only under instructions from the Engineer.

The withdrawal of the timber shall be done carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded with, systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber.

In the case of open timbering, the entire surface of the side of trench or pit is not required to be covered. The vertical boards of minimum 25 cm x 4 cm sections shall be spaced sufficiently apart to leave unsupported strips of maximum 50 cm average width. The detailed arrangement, sizes of the timber and the spacings shall be subject to the approval of the Engineer. In all other respects, the Specifications for close timbering shall apply to open timbering.

In case of large pits and open excavations, where shoring is required for securing safety of adjoining structures or for any other reasons and where the planking across sides of excavations/pits cannot be strutted against, suitable inclined struts supported on the excavated bed shall be provided. The load from such struts shall be suitably distributed on the bed to ensure no yielding of the strut. If however, Engineer directs any timbering to be left-in, keeping in mind the type of construction or any other factor, Contractor shall be paid for at the scheduled item rate for such left-in timbering.

3.15 Measurement

Unless separately provided for in the Schedule of Quantities, the actual effective area of shored faces as approved by Engineer shall be measured in sq.m. The area of planking embedded in the bed/sides of excavation will not be considered, nor the area supporting inclined struts in case of large pits/open excavation. All planks, boards, wallings, verticals, struts, props and all other materials required for shoring and subsequent safe dismantling and removal shall be included in the quoted unit rates.

3.16 Dewatering

The Contractor shall ensure that the excavation and the structures are free from water during construction and shall take all necessary precautions and measures to exclude ground/rain water so as to enable the works to be carried out in reasonably dry conditions in accordance with the construction programme. Sumps made for dewatering must be kept clear of the excavations/trenches required for further work. The method of pumping shall be approved by Engineer, but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction. The dewatering shall be continued for at least (7) seven days after the last pour of the concrete. The Contractor shall, however, ensure that no damage to the structure results on stopping of dewatering.

The Contractor shall study the sub-soil conditions carefully and shall conduct any tests necessary at the site with the approval of the Engineer to test the permeability and drainage conditions of the sub-soil for excavation, concreting etc., below ground level.

The scheme for dewatering and disposal of water shall be approved by the Engineer. The Contractor shall suitably divert the water obtained from dewatering from such areas of site where a buildup of water in the opinion of the Engineer obstructs the progress of the work,

leads to insanitary conditions by stagnation, retards the speed of construction and is detrimental to the safety of men, materials, structures and equipment.

When there is a continuous inflow of water and the quantum of water to be handled is considered in the opinion of Engineer, to be large, a well point system- single stage or multistage, shall be adopted. The Contractor shall submit to the Engineer, details of his well point system including the stages, the spacing, number and diameter of well points, headers etc., and the number, capacity and location of pumps for approval. Unless separately provided for in the Schedule of prices, the cost of dewatering shall be included in the item rate for excavation.

3.17 Measurement

Unless separately provided for in the Schedule of quantities, dewatering is deemed to have been included in the unit rates quoted for excavation. If separately provided for, the unit of measurement shall be as indicated in the Schedule of Quantities.

3.18 Rain Water Drainage

Grading in the vicinity of excavation shall be such as to exclude rain/ surface water draining into excavated areas. Excavation shall be kept clean of rain and such water as the Contractor may be using for his work by suitably pumping out the same. The scheme for pumping and discharge of such water shall be approved by the Engineer.

3.19 Earthen Embankment Construction

3.19.1 Scope

These Specifications shall apply to the construction of embankments including sub grades, earthen shoulders and miscellaneous backfills with approved materials obtained from roadway and drain excavation, borrow pits or other sources. All embankments, subgrade, earthen shoulders and miscellaneous backfills shall be constructed in accordance with the requirements of these Specifications and in conformity with the lines, grades, and cross-sections shown on the Drawings or as directed by the Engineer.

3.19.2 Physical Requirements of materials

The materials used in embankments, sub grades, earthen shoulders and miscellaneous backfills shall be soil, moorum, gravel, a mixture of those or any other material approved by the Engineer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment/subgrade.

The following types of material shall be considered unsuitable for embankment:

Materials from swamps, marshes and bogs.
Peat, log, stump and perishable material any soil that classifies as OL, OI, OH or Pt in accordance with IS: 1498.
Materials susceptible to spontaneous combustion.
Materials in frozen conditions.

Clay having liquid limit exceeding 70 and plasticity index exceeding 45 and
Materials with salts resulting in leaching in the embankment.

Expansive clay exhibiting marked swell and shrinkage properties ("free swelling index" exceeding 50 percent when tested as per IS: 2720 Part 40) shall not be used as a fill material. Where expansive clay with acceptable "free swelling index" value is used as a fill material, subgrade and top 500 mm portion of the embankment just below subgrade shall be non-expansive in nature.

Any fill material with a soluble sulphate content exceeding 1.9 grams of sulphate (expressed as SO3) per litre when tested in accordance with BS: 1377 Test 10, but using a 2:1 water-soil ratio shall not be deposited within 500 mm or other distance described in the Contract, of concrete, cement bound materials or other cementitious materials forming part of the Permanent Works.

Materials with a total sulphate content (expressed as SO3) exceeding 0.5 percent by mass, when tested in accordance with BS: 1377 Test 9 shall not be deposited within 500 mm, or other distances described in the Contract, of metallic items forming part of the Permanent Works.

The size of the coarse material in the mixture of earth shall ordinarily not exceed 75 mm when being placed in the embankment and 50 mm when placed in the subgrade. However, the Engineer may at his discretion permit the use of material coarser than this also if he is satisfied that the same will not present any difficulty as regards the placement of fill material and its compaction to the requirements of these Specifications. The maximum particle size shall not be more than two-thirds of the compacted layer thickness.

Ordinarily, only the materials satisfying the density requirements given in Table I shall be employed for the construction of the embankment and the subgrade.

Table-I. Density Requirements of Embankment and Subgrade Materials

Sr.	Type of Work	Maximum laboratory dry unit weight when tested as per IS: 2270 (Part 8)
1.	Embankments up to 3 meters height, not subjected to extensive flooding.	Not less than 15.2 kN/cum.
2.	Embankments exceeding 3 meters height or embankments of any height subject to long periods of inundation	Not less than 16.0 kN/cum.
3.	Sub grades and earthen shoulders / verges / backfill	Not less than 17.5 kN/cum.

Notes:

This Table is not applicable for lightweight fill material e.g. cinder, fly ash etc.

The Engineer may relax these requirements at his discretion taking into account the availability of materials for construction and other relevant factors.

The material to be used in subgrade should also satisfy design CBR at the dry unit weight applicable as per Table-II.

3.19.3 General requirements of materials

The materials for embankment shall be obtained from approved sources with preference given to materials becoming available from nearby roadway excavation or any other excavation under the same Contract.

The work shall be so planned and executed that the best available materials are saved for the subgrade and the embankment portion just below the subgrade.

Borrow Materials

Where the materials are to be obtained from designated borrow areas, the location, size and shape of these areas shall be as indicated by the Engineer and the same shall not be opened without his written permission. Where specific borrow areas are not designated by the Employer / the Engineer, arrangement for locating the source of supply of material for embankment and subgrade as well as compliance to environmental requirements in respect of excavation and borrow areas as stipulated, from time to time by the Ministry of Environment and Forests, Government of India and the local bodies, as applicable, shall be the sole responsibility of the Contractor.

Borrow pits along the road shall be discouraged. If permitted by the Engineer, these shall not be dug continuously. Ridges of not less than 8 m width should be left at intervals not exceeding 300 m. Small drains shall be cut through the ridges to facilitate drainage. The depth of the pits shall be so regulated that their bottom does not cut an imaginary line having a slope of 1 vertical to 4 horizontal projected from the edge of the final section of the bank, the maximum depth in any case being limited to 1.5 m. Also, no pit shall be dug within the offset width from the toe of the embankment required as per the consideration of stability with a minimum width of 10 m.
Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction plants is operating at the place of deposition.

No excavated acceptable material other than surplus to requirements of the Contract shall be removed from the site. Should the Contractor be permitted to remove acceptable material from the site to suit his operational procedure, then he shall make good any consequent deficit of material arising there from.

Where the excavation reveals a combination of acceptable and unacceptable materials, the Contractor shall, unless otherwise agreed by the Engineer, carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the permanent works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

The Contractor shall ensure that he does not adversely affect the stability of excavation or fills by the methods of stockpiling materials, use of plants or siting of temporary buildings or structures.

The Contractor shall obtain representative samples from each of the identified borrow areas and have these tested at the site laboratory following a testing programme approved by the

Engineer. It shall be ensured that the subgrade material when compacted to the density requirements as in Table II shall yield the design CBR value of the subgrade.

Table-II. Compaction Requirements for Embankment and Subgrade

Sr	Type of work/ material	Relative compaction as percentage of max. laboratory dry density as per IS: 2720 (Part 8)
1.	Subgrade and earthen shoulders	Not less than 97
2.	Embankment	Not less than 95
3.	Expansive Clays	
	a) Subgrade and 500 mm portion just below the subgrade	Not allowed
	b) Remaining portion of embankment	Not less than 90

The Contractor shall at least 7 working days before commencement of compaction submit the following to the Engineer for approval:

The values of maximum dry density and optimum moisture content obtained in accordance with IS: 2720 (Part 7) or (Part 8), as the case may be, appropriate for each of the fill materials he intends to use.
A graph of density plotted against moisture content from which each of the values in (1) above of maximum dry density and optimum moisture content were determined.
The Dry density-moisture content-CBR relationships for light, intermediate and heavy compactive efforts (light corresponding to IS: 2720 (Part 7), heavy corresponding to IS: 2720 (Part 8) and intermediate in-between the two) for each of the fill materials he intends to use in the subgrade.

Once the above information has been approved by the Engineer, it shall form the basis for compaction.

3.19.4 Construction Operations for Embankments

Setting out

After the site has been cleared to chapter-1, the work shall be set out. The limits of embankment/subgrade shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. The embankment / subgrade shall be built sufficiently wider than the design dimension so that surplus materials may be trimmed, ensuring that the remaining material is to the desired density and in position specified and conforms to the specified side slopes.

Dewatering

If the foundation of the embankment is in an area with stagnant water, and in the opinion of the Engineer it is feasible to remove it, the same shall be removed by bailing out or pumping, as directed by the Engineer and the area of the embankment foundation shall be kept dry. Care shall be taken to discharge the drained water so as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is

caused, it shall be the sole responsibility of the Contractor to repair / restore it to its original condition or compensate for the damage at its own cost. If the embankment is to be constructed under Water, Clause 3.19.5 shall apply.

Stripping and Storing topsoil

In localities where most of the available embankment materials are not conducive to plant growth, or when so directed by the Engineer, the topsoil from all areas of cutting and from all areas to be covered by embankment foundation shall be stripped to specified depths not exceeding 150 mm and stored in stockpiles of height not exceeding 2 m for covering embankment slopes, cut slopes and other disturbed areas where re-vegetation is desired. Topsoil shall not be unnecessarily trafficked either before stripping or when in a stockpile. Stockpiles shall not be surcharged or otherwise loaded and multiple handling shall be kept to a minimum.

Compacting ground supporting Embankment / Subgrade

When necessary, the original ground shall be leveled to facilitate placement of first layer of embankment, scarified, mixed with water and then compacted by rolling so as to achieve minimum dry density as given in Table-II.

In case where the difference between the subgrade level (top of the subgrade on which pavement rests) and ground level is less than 0.5 m and the ground does not have 97 percent relative compaction with respect to the dry density as given in Table-I, the ground shall be loosened up to a level 0.5 m below the subgrade level, watered and compacted in layers in accordance with Clause 3.19.4 to not less than 97 percent of dry density as given in Table-II.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced by approved materials laid in layers to the required degree of compaction.

Embankment or subgrade work shall not proceed until the foundations of embankments/subgrade have been inspected by the Engineer for satisfactory condition and approved.

Any foundation treatment specified for embankments especially high embankments, resting on suspect foundations as revealed by borehole logs shall be carried out in a manner and to the depth as desired by the Engineer. Where the ground on which embankment is to be built has any of the material types specified in Clause 3.19.2, at least 500 mm of such material must be removed and replaced by acceptable fill material before embankment construction commences.

Spreading material in layers and bringing to appropriate moisture content

The embankment and subgrade material shall be spread in layers of uniform thickness not exceeding 200 mm compacted thickness over the entire width of embankment by mechanical means, finished by a motor grader and compacted as per Clause 3.19.4. The motor grader blade shall have hydraulic control suitable for initial adjustment and maintain the same so as to achieve the specific slope and grade. Successive layers shall not be placed until the layer under

construction has been thoroughly compacted to the specified requirements as in Table-II and got approved by the Engineer. Each compacted layer shall be finished parallel to the final cross-section of the embankment.

Moisture content of the material shall be checked at the site of placement prior to commencement of compaction; if found to be out of agreed limits, the same shall be made good. Where water is required to be added in such construction, water shall be sprinkled from a water tanker fitted with sprinkler capable of applying water uniformly with a controllable rate of flow to variable widths of surfaces but without any flooding. The water shall be added uniformly and thoroughly mixed in soil by blading, discing or harrowing until and uniform moisture content is obtained throughout the depth of the layer.

If the material delivered to the roadbed is too wet, it shall be dried, by aeration and exposure to the sun, till the; moisture content is acceptable for compaction. Should circumstances arise, where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, compaction work shall be suspended.

Moisture content of each layer of soil shall be checked in accordance with IS: 2720 (Part 2), and unless otherwise mentioned, shall be so adjusted, making due allowance for evaporation losses, that at the time of compaction it is in the range of 1% above to 2% below the optimum moisture content determined in accordance with IS: 2720 (Part 7) or IS: 2720 (Part 8) as the case may be. Expansive clays shall, however, be compacted at moisture content corresponding to the specified dry density, but on the wet side of the optimum moisture content obtained from the laboratory compaction curve.

After adding the required amount of water, the soil shall be processed by means of graders, harrows, rotary mixers or as otherwise approved by the Engineer until the layer is uniformly wet.

Clods or hard lumps of earth shall be broken to have a maximum size of 75 mm when being placed in the embankment and a maximum size of 50 mm when being placed in the subgrade.

Embankment and other areas of fill shall, unless otherwise required in the Contract or permitted by the Engineer, be constructed evenly over their full width and their fullest possible extent and the Contractor shall control and direct construction plant and other vehicular traffic uniformly over them. Damage by construction plant and other vehicular traffic shall be made good by the Contractor with material having the same characteristics and strength as the material had before it was damaged.

Embankments and other areas of unsupported fills shall not be constructed with steeper side slopes, or to greater widths than those shown in the Contract, except to permit adequate compaction at the edges before trimming back, or to obtain the final profile following any settlement of the fill and the underlying material.

Whenever fill is to be deposited against the face of a natural slope, or sloping earthworks face including embankments, cuttings, other fills and excavations steeper than 1 vertical on 4 horizontal, such faces shall be benched as per Clause 3.19.5 immediately before placing the subsequent fill.

All permanent faces of side slopes of embankments and other areas of fill formed shall, subsequent to any trimming operations, be reworked and sealed to the satisfaction of the Engineer by tracking a tracked vehicle, considered suitable by the Engineer, on the slope or any other method approved by the Engineer.

Compaction

Only the compaction equipment approved by the Engineer shall be employed to compact the different material types encountered during construction. Smooth wheeled, vibratory, pneumatic tyred, sheepfoot or pad foot rollers, etc., of suitable size and capacity as approved by the Engineer shall be used for the different types and grades of materials required to be compacted either individually or in suitable combinations.

The compaction shall be done with the help of vibratory roller of 80 to 100 kN static weight with plain or pad foot drum or heavy pneumatic tyred roller of adequate capacity capable of achieving required compaction.

The Contractor shall demonstrate the efficiency of the equipment he intends to use by carrying out compaction trials. The procedure to be adopted for these site trials shall first be submitted to the Engineer for approval.

Earthmoving plant shall not be accepted as compaction equipment nor shall the use of a lighter category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account.

Each layer of the material shall be thoroughly compacted to the densities specified in Table-I. Subsequent layers shall be placed only after the finished layer has been tested according to Clause 903.2.2 of MORTH Specifications for Roads and Bridge Works (V Revision) and accepted by the Engineer. The Engineer may permit measurement of field dry density by a nuclear moisture / density gauge used in accordance with agreed procedure and the gauge is calibrated to provide results identified to that obtained from tests in accordance with IS: 2720 (Part 28). A record of the same shall be maintained by the Contractor.

When density measurements reveal any soft areas in the embankment / subgrade / earthen shoulders, further compaction shall be carried out as directed by the Engineer. If inspite of that the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted to the density requirements and satisfaction of the Engineer.

Drainage

The surface of the embankment / subgrade at all times during construction shall be maintained at such a cross fall (not flatter than that required for effective drainage of an earthen surface) as will shed water and prevent ponding.

Repairing of damages caused by rain / spillage of water

The soil in the affected portion shall be removed in such areas as directed by the Engineer before next layer is laid and refilled in layers and compacted using appropriate mechanical means such as small vibratory roller, plate compactor or power rammer to achieve the required density in accordance with Clause 3.19.5. If the cut is not sufficiently wide for use of required mechanical means for compaction, the same shall be widened suitably to permit their use for proper compaction. Tests shall be carried out as directed by the Engineer to ascertain the density requirements of the repaired area. The work of repairing the damages including widening of the cut, if any, shall be carried out by the Contractor at his own cost, including the arranging of machinery / equipment for the purpose.

Finishing operations

Finishing operations shall include the work of shaping and dressing the shoulders / verge / roadbed and side slopes to conform to the alignment, levels, cross-sections and dimensions shown on the Drawings or as directed by the Engineer subject to the surface tolerance described in **Clause 902** of MORTH Specifications for Roads and Bridge Works (V Revision). Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain.

The topsoil, removed and conserved earlier shall be spread over the fill slopes as per directions of the Engineer to facilitate the growth of vegetation. Slopes shall be roughened and moistened slightly prior to the application of the topsoil in order to provide satisfactory bond. The depth of the topsoil shall be sufficient to sustain plant growth, the usual thickness being from 75 mm to 150 mm.

Where directed, the slopes shall be turfed with sods in accordance with **Clause 3.20**. If seeding and mulching of slopes is prescribed, this shall be done to the requirement of **Clause 3.21**.

When earthwork operations have been substantially completed, the road area shall be cleared of all debris, and ugly scars in the construction area responsible for objectionable appearance eliminated.

3.19.5 Construction of Embankment and Subgrade under Special Conditions

Earthwork for widening existing road embankment

When an existing embankment and / or subgrade is to be widened and its slope are steeper than 1 vertical on 4 horizontal, continuous horizontal benches, each at least 300 mm wide, shall be cut into the old slope for ensuring adequate bond with the fresh embankment / subgrade material to be added. The material obtained from cutting of benches could be utilized in the widening of the embankment / subgrade. However, when the existing slope against which the fresh material is to be placed is flatter than 1 vertical on 4 horizontal, the slope surface may only be ploughed or scarified instead of resorting to benching.

Where the width of the widened portions is insufficient to permit the use of conventional rollers, compaction shall be carried out with the help of small vibratory rollers / plate compactors / power rammers of any other appropriate equipment approved by the Engineer.

End dumping of material from trucks for widening operations shall be avoided except in difficult circumstances when the extra width is too narrow to permit the movement of any other types of hauling equipment.

Earthwork for embankment and subgrade to be placed against sloping ground:

Where an embankment / subgrade is to be placed against sloping ground, the latter shall be appropriately benched or ploughed / scarified as required in **Clause 3.19.5** before placing the embankment / subgrade material. Extra earthwork involved in benching or due to ploughing / scarifying etc. shall be considered incidental to the work.

For wet conditions, benches with slightly inward fall subsoil drains at the lowest point shall be provided as per the Drawings, before the fill is placed against sloping ground.

Earthwork over existing road surface:

Where the embankment is to be placed over an existing road surface, the work shall be carried out as indicated below:

If the existing road surface is of granular or bituminous type and lies within 1 m of the new subgrade level, the same shall be scarified to a depth of 50 mm or more if specified, so as to provide ample bond between the old and new material ensuring that at least 500 mm portion below the top of new subgrade level is compacted to the desired density.

If the existing road surface is of cement concrete type and lies within 1 m of the new subgrade level the same shall be removed completely.

If the level difference between the existing road surface and the new formation level is more than 1 m, the existing surface shall be permitted to stay in place without any modification.

Embankment and subgrade around structures:

To avoid interference with the construction of abutments, wing walls or return walls of culvert / bridge structures, the Contractor shall, at points to be determined by the Engineer suspend work on embankment forming approaches to such structures, until such time as the construction of the latter is sufficiently advanced to permit the completion of approaches without the risk of damage to the structure.

Unless directed otherwise, the filling around culverts, bridges and other structures up to a distance of twice the height of the road from the back of the abutment shall be carried out independent of the work on the main embankment. The fill material shall not be placed against any abutment or wing wall, unless permission has been given by the Engineer but in any case not until the concrete or masonry has been in position for 14 days.

The embankment and subgrade shall be brought up simultaneously in equal layers on each side of the structure to avoid displacement in equal layers on each side of the structure to avoid displacement and unequal pressure. The sequence of work in this regard shall be got approved from the Engineer.

The material used for backfill shall not be an organic soil or highly plastic clay having plasticity index and liquid limit more than 20 and 40 respectively when tested according to IS: 2720 (Part 5). Filling behind abutments and wing walls for all structures shall conform to the general guidelines given in Appendix 6 of IRC:78 (Standard Specifications and Code of Practice for Road Bridges-Section VII) in respect of the type of material, the extent of backfill, its laying and compaction etc. The fill material shall be deposited in horizontal layers in loose thickness and compacted thoroughly to the requirements of **Table-II.**

Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneously with the laying of fill material. The material used for filter shall conform to the requirements for filter medium spelt out in **Clause 2502** of MORTH Specifications for Roads and Bridge Works (V Revision) unless otherwise specified in the Contract.

Where it may be impracticable to use conventional rollers, the compaction shall be carried out by appropriate mechanical means such as small vibratory roller, plate compactor or power rammer. Care shall be taken to see that the compaction equipment does not hit or come too close to any structural member so as to cause any damage to them or excessive pressure against the structure.

Construction of Embankment over Ground Incapable of Supporting Construction Equipment:

Where embankment is to be constructed across ground which will not support the weight of repeated heavy loads of construction equipment, the first layer of the fill may be constructed by placing successive loads of material in a uniformly distributed layer of a minimum thickness required to support the construction equipment as permitted by the Engineer. The Contractor, if so desired by him, may also use suitable geosynthetic material to increase the bearing capacity of the foundation. This exception to normal procedure will not be permitted where, in the opinion of the Engineer, the embankments could be constructed in the approved manner over such ground by the use of lighter or modified equipment after proper ditching and drainage have been provided. Where this exception is permitted, the selection of the material and the construction procedure to obtain an acceptable layer shall be the responsibility of the Contractor. The cost of providing suitable traffic conditions for construction equipment over any area of the Contract will be the responsibility of the Contractor and no extra payment will be made to him. The remainder of the embankment shall be constructed as specified in Clause 3.19.4.

Embankment construction under water

Where filling or backfilling is to be placed under water, only acceptable granular material or rock shall be used unless otherwise approved by the Engineer. Acceptable granular material shall consist of graded, hard durable particles with maximum particle size not exceeding 75 mm. The material should be non-plastic having uniformity coefficient of not less than 10. The material placed in open water shall be deposited by end tipping without compaction.

Earthwork for high embankment

In the case of high embankments, the Contractor shall normally use the material from the specified borrow area. In case he desires to use different material for his own convenience, he shall have to carry out necessary soil investigations and redesign the high embankment at his own cost. The Contractor shall then furnish the soil test data and design of high embankment for approval of the Engineer, who reserve the right to accept or reject it.

If necessary, stage construction of fills and any controlled rates of filling shall be carried out in accordance with the Contract including installation of instruments and its monitoring.

Where required, the Contractor shall surcharge embankments or other areas of fill with approved material for the periods specified in the Contract. If settlement of surcharged fill results in any surcharging material, which is unacceptable for use in the fill being surcharged, lying below formation level, the Contractor shall remove the unacceptable material and dispose it as per direction of the Engineer. He shall then bring the resultant level up to formation level with acceptable material.

Settlement period

Where settlement period is specified in the Contract, the embankment shall remain in place for the required settlement period before excavating for abutment, wingwall, retaining wall, footings, etc., or driving foundation piles. The duration of the required settlement period at each location shall be as provided for in the Contract or as directed by the Engineer.

3.19.6 Plying of Traffic

Construction and other vehicular traffic shall not use the prepared surface of the embankment and / or subgrade without the prior permission of the Engineer. Any damage arising out of such use shall, however, be made good by the Contractor at his own expense as directed by the Engineer.

3.19.7 Surface Finish and Quality Control of Work

The surface finish of construction of subgrade shall conform to the requirements of Clause 902 of MORTH Specifications for Roads and Bridge Works (V Revision). Control on the quality of materials and works shall be exercised in accordance with Clause 903 of MORTH Specifications for Roads and Bridge Works (V Revision).

3.19.8 Subgrade Strength

It shall be ensured prior to actual execution that the borrow area material to be used in the subgrade satisfies the requirements of design CBR.

Subgrade shall be compacted and finished to the design strength consistent with other physical requirements. The actual laboratory CBR values of constructed subgrade shall be determined on undisturbed samples cut out from the compacted subgrade in CBR mould fitted with

cutting shoe or on remoulded samples, compacted to the field density at the field moisture content.

3.19.9 Measurements for Payment

Earth embankment/subgrade construction shall be measured separately by taking cross sections at intervals in the original position before the work starts and after its completion and computing the volumes of earthwork in cubic metres by the method of average end areas.

The measurement of fill material from borrow areas shall be the difference between the net quantities of compacted fill and the net quantities of suitable material brought from roadway and drainage excavation. For this purpose, it shall be assumed that one cum. of suitable material brought to site from road and drainage excavation forms one cum. of compared fill and all bulking or shrinkage shall be ignored.

Construction of embankment under water shall be measured in cum.

Construction of high embankment with specified material and in specified manner shall be measured in cum.

Stripping including storing and reapplication of topsoil shall be measured in cum.

Work involving loosening and recompacting of ground supporting embankment / subgrade shall be measured in cum.

Removal of unsuitable material at embankment / subgrade foundation and replacement with suitable material shall be measured in cum.

Scarifying existing granular / bituminous road surface shall be measured in square metres.

Dismantling and removal of existing cement concrete pavement shall measured vide Clause 202.6 of MORTH Specifications for Roads and Bridge Works (V Revision).

Filter medium and backfill material behind abutments, wing walls and other retaining structures shall be measured as finished work in position in cum.

3.19.10 Rates

The Contract unit rates for the items of embankment and subgrade construction shall be payment in full for carrying out the required operations including full compensation for:

Cost of arrangement of land as a source of supply of material of required quantity for construction unless provided otherwise in the Contract;

Setting out;

Compacting ground supporting embankment / subgrade except where removal and replacement of unsuitable material or loosening and recompacting is involvedScarifying or

cutting continuous horizontal benches 300 mm wide on side slopes of existing embankment and subgrade as applicable.Cost of watering or drying of material in borrow areas and / or embankment and subgrade during construction as required.

Spreading in layers bringing to appropriate moisture content and compacting to Specification requirements. Shaping and dressing top and slopes of the embankment and subgrade including rounding of corners. Restricted working at sites of structures, Working on narrow width of embankment and subgrade.

Excavation in all soils from borrow pits / designated borrow areas including clearing and grubbing and transporting the material to embankment and subgrade site with all lifts and leads unless otherwise provided for in the Contract;

All labour, materials, tools, equipment and incidentals necessary to complete the work to the Specifications, Dewatering and Keeping the embankment / completed formation free of water. In case the Contract unit rate specified is not inclusive of all leads, the unit rate for transporting material beyond the initial lead, as specified in the Contract for construction of embankment and subgrade shall be inclusive of full compensation for all labour, equipment, tools and incidentals necessary on account of the additional haul or transportation involved beyond the specified initial lead.

The Contract unit rate for the items of stripping and storing topsoil and of reapplication of topsoil shall include full compensation for all the necessary operations including all lifts, but leads up to 1000 m.

The Contract unit rate for loosening and recompacting the loosened materials at subgrade shall include full compensation for loosening to the specified depth, including breaking clods, spreading in layers, watering where necessary and compacting to the requirements.

The Contract unit rate for scarifying existing granular / bituminous road surface shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals necessary to complete the work. This will also comprise of handling, salvaging, stacking and disposing of the dismantled materials within all lifts and up to a lead of 1000 m or as otherwise specified.

Clause 202.7 of MORTH Specifications for Roads and Bridge Works (V Revision) shall apply as regards Contract unit rate for dismantling and removal of existing cement concrete pavement.

The Contract unit rate for providing and laying filters material behind abutments shall be payment in full for carrying out the required operations including all materials, labour, tools, equipment and incidentals to complete the work to Specifications.
Clause 3.19.5 shall apply as regards Contract unit rate for construction of embankment under water.

Clause 3.19.5 shall apply as regards Contract unit rate for construction of high embankment. It shall include cost of instrumentation, its monitoring and settlement period, where specified in the Contract or directed by the Engineer.

3.20 Soil Erosion and Sedimentation Control

3.20.1 Scope

This work shall consist of measures as shown on plans or as directed by the Engineer to control soil erosion, sedimentation and water pollution, through use of berms, dikes, sediment basins, fibre mats, mulches, grasses, slope drains, and other devices.

3.20.2 Materials

All materials shall meet commercial grade standards and shall be approved by the Engineer before being used in the work.

3.20.3 Construction Operations

Prior to the start of the relevant construction, the Contractor shall submit to the Engineer for approval his schedules for carrying out temporary and permanent erosion / sedimentation control works as are applicable for the items of clearing and grubbing, roadway and drainage excavation, embankment / subgrade construction, bridges and other structures across water course, pavement courses and shoulders. He shall also submit for approval his proposed method of erosion / sedimentation control on service road and borrowpits and his plan for disposal of waste materials. Work shall not be started until the erosion / sedimentation control schedules and methods of operations for the applicable construction have been approved by the Engineer.

The surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and fill operations shall be limited to the extent practicable. The Contractor may be directed to provide immediate permanent or temporary erosion and sedimentation control measures to prevent soil erosion and sedimentation that will adversely affect construction operations, damage adjacent properties, or cause contamination of nearby streams or other water courses, lakes, reservoirs etc. Such work may involve the construction of temporary berms, dikes, sediment basins, slope drains and use of temporary mulches, fabrics, mats, seeding, or other control devices or methods as necessary to control erosion and sedimentation. Cut and fill slopes shall be seeded and turfed as required on the plans.

The Contractor shall be required to incorporated all permanent erosion and sedimentation control features into the project at the earliest practicable time as outlined in his accepted schedule to minimize the need for temporary erosion and sedimentation control measures.

Temporary erosion / sedimentation and pollution control measures will be used to control the phenomenon of erosion, sedimentation, and pollution that may develop during normal construction practices, but may neither be foreseen during the design stage nor associated with permanent control features on the Project.

Where erosion or sedimentation is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion or sedimentation control features can follow immediately thereafter if the project conditions permit; otherwise, temporary erosion or sedimentation control measures may be required

between successive construction stages. Under no conditions shall a large surface area of erodible earth material be exposed at one time by clearing and grubbing or excavation without prior approval of the Engineer.

The Engineer may limit the area of excavation, borrow and embankment operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding and other such permanent erosion, sedimentation and pollution control measures, in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion / sedimentation control measures shall be taken immediately to the extent feasible and justified.

In the event temporary erosion, sedimentation and pollution control measures become necessary due to the Contractor's negligence, carelessness or failure to install permanent controls as a part of the work as scheduled or ordered by the Engineer, these shall be carried out at the Contractor's own expense. Temporary erosion, sedimentation and pollution control work required, which is not attributed to the Contractor's negligence, carelessness of failure to install permanent controls, will be performed as ordered by the Engineer.

Temporary erosion, sedimentation and pollution control may include construction work outside the right-of-way where such work is necessary as result of road construction such as borrow pit operations, service roads and equipment storage sites.

The temporary erosion, sedimentation and pollution control features installed by the Contractor shall be acceptably maintained by him till these are needed, unless otherwise agreed by the Engineer.

3.20.4 Measurements for Payment

The soil erosion, sedimentation and pollution control works will be measured in terms of units specified in the Bill of Quantities for the respective items.

3.20.5 Rates

The contract unit rate for different items of soil erosion, sedimentation and pollution control works shall be payment in full for carrying out all required operations including full compensation for all labour, tools, equipment and incidents to complete the works to the Specifications.

3.21 Turfing with Sods

3.21.1 Scope

This work shall consist of furnishing and laying of the live sod of perennial turf forming grass on embankment slopes, verges (earthen shoulders) or other locations as directed by the Engineer. Unless otherwise specified, the work shall be taken up as soon as possible following construction of the embankment, provided the season is favorable for establishment of the sod.

3.21.2 Materials

The sod shall consist of dense, well-rooted growth of permanent and desirable grasses, indigenous to the locality where it is to be use, and shall be practically free from weeds or other undesirable matter. At the time the sod is cut, the grass on the sod shall have a length of approximately 50 mm and the sod shall have freed of debris.

Thickness of the sod shall be as uniform as possible, with some 50-80 mm or so of soil covering the grass roots depending on the nature of the sod, so that practically all the dense root system of the grasses is retained in the sod strip. The sods shall be cut in rectangular strips of uniform width, not less than about 250 mm X 300 mm in size but not so large that it is inconvenient to handle and transport these without damage. During wet weather, the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather shall be watered before lifting to ensure its vitality and prevent the dropping of the soil in handling.

3.21.3 Construction Operations for Turfing with Sods

Preparation of earth bed

The area to be sodded shall have been previously constructed to the required slope and cross section. Soil on the area shall be loosened, freed of all stones larger than 50 mm size, sticks, stumps and any undesirable foreign matter, and brought to a reasonably fine granular texture to a depth of not less than 25 mm for receiving the sod.

Where required, topsoil shall be spread over the slopes. Prior to placing the topsoil, the slopes shall be scarified to a depth which, after settlement, will provide the required nominal depth shown on the plans. Spreading shall not be done when the ground is excessively wet.

Following soil preparation and top soiling, where required, fertilizer and ground limestone when specified shall be spread uniformly at the rate indicated on the plans. After spreading, the materials are incorporated in the soil by discing or other means to the depths shown on the plans.

Placing the sods

The prepared sod bed shall be moistened to the loosened depth, if not already sufficiently moist, and the sod shall be placed thereon within approximately 24 hours after the same had been cut. Each sod strip shall be laid edge to edge and such that the joints caused by abutting ends are staggered. Every strip, after it is snugly placed against the strips already in position, shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil.

On side slopes steeper than 2 (horizontal) to 1 (vertical), the laying of sods shall be started from bottom upwards. At points where water may flow over a sodded area, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth placed over this followed by its through compaction.

Staking the sods

Where the side slope is 2 (horizontal) to 1 (vertical) or steeper and the distance along the slope is more than 2 m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000 mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods to be almost flush with them.

Top dressing

After the sods have been laid in position, the surface shall be cleaned of loose sod, excess soil and other foreign material. Thereafter, a thin layer of topsoil shall be scattered over the surface of top dressing and the area thoroughly moistened by sprinkling with water.

Watering and maintenance

The sods shall be watered by the Contractor for a period of at least four weeks after laying. Watering shall be so done as to avoid erosion and prevent damage to sodded areas by wheels of water tanks.

The Contractor shall erect necessary warning signs and barriers, repair or replace sodded areas failing to show uniform growth of grass or damaged by his operations and shall otherwise maintain the sod at his cost until final acceptance.

Measurement for Payment

Turfing with sods shall be measured as finished work in square metres.

Rate

The Contract unit rate for turfing with sods shall mean payment in full for carrying out all the required operations explained above including compensation for:

Furnishing all the materials to be incorporated in the Works with all leads and lifts; and
All labour, tools, equipment and incidental to complete the work in accordance with these Specifications.

3.22 Seeding and Mulching

3.22.1 Scope

This shall consist of preparing slopes, placing topsoil, furnishing all seeds, commercial or organic fertilizers and mulching materials, providing jute netting and placing and incorporation the same on embankment slopes or other locations designated by the Engineer or shown in the Contract documents.

3.22.2 Materials

Seeds

The seeds shall be approved quality and type suitable for the soil on which these are to be

applied and shall have acceptable purity and germination to requirements set down by the Engineer.

Fertilizer

This shall consist of standard commercial materials and conform to the grade specified. Organic manure shall be fully purified organic matter such as cow dung.

Mulching materials

This shall consist of straw, hay wood shavings or sawdust and shall be delivered dry. They shall be reasonably free of weed seed and such foreign materials as may detract from their effectiveness as mulch or be injurious to the plant growth.

Topsoil

Topsoil shall not be obtained from an area known to have noxious weeds growing in it. If treated with herbicides or sterilents, it shall be got tested by appropriate agricultural authority to determine the residual in the soil. Topsoil shall contain less than 2 per cent and more than 12 per cent organic matter.

Bituminous Emulsion

A suitable grade of bituminous cutback or emulsion used as a tie down for mulch shall be as described in the Contract document or as desired by the Engineer. Emulsified bitumen shall not contain any solvent or diluting agent toxic to plant life.

Netting

Jute netting shall be undyed jute yam woven into a uniform open weave with approximate 2.5 cm square openings. Geonetting shall be made of uniformly extruded rectangular mesh having mesh opening of 2 cm x 2 cm. The colour may be black or green. It shall weigh not less than 3.8 kg per 1000 sq. m.

3.22.3 Seeding Operations

Seed-bed Preparation

The area to be seeded shall be brought to the required slope and cross-section by filling, reshaping eroded areas and refinishing slopes, median etc. Topsoil shall be evenly spread over the specified areas to the depth shown on the plans, unless otherwise approved by the Engineer. The see-bed preparation shall consist of eliminating all live plants by suitable means using agricultural implements. All stones 150 mm in smallest dimension and larger shall be removed.

The soil shall be excavated on the contour to a depth of 100 mm. All clods large than 25 mm in diameter shall be crushed and packed. Where necessary, water shall then be applied. All topsoil shall be compacted unless otherwise specified or approved by the Engineer.

Compaction shall be by slope compactor, cleated tractor or similar equipment approved by the Engineer. Equipment shall be so designed and constructed as to produce a uniform rough textured surface ready for seeding and mulching and which will bond the topsoil to the underlying material. The entire area shall be covered by a minimum of 4 passes or 2 round trips of the roller or approved equipment.

Fertilizer application

Fertilizer to the required quantities shall be spread and thoroughly incorporated into the soil surface as a part of the seed-bed preparation.

Planting of seeds

All seeds shall be planted uniformly at the approved rate. Immediately after sowing, the area shall be raked, dragged or otherwise treated so as to cover the seeds to a depth of 6 mm. The operation of seed sowing shall not be performed when the ground is muddy or when the soil or weather conditions would otherwise prevent proper soil preparation and subsequent operations.

Soil Moisture and Watering requirements

Soil moisture shall exist throughout the zone from 25 mm to at least 125 mm below the surface at the time of planting. Watering off the seeded areas shall be carried out as determined by the Engineer.

Mulching, Applying Bituminous Emulsion and Jute Netting / Geonetting

Within 24 hours of seeding, mulching material mixed with organic manure shall be placed so as to form a continuous, unbroken cover of approximate uniform thickness of 25 mm using an acceptable mechanical blower. Mulching material shall be held in place and made resistant to being blown away by suitable means approved by the Engineer. When called for in the Contract documents, mulch material shall be anchored in place with bituminous emulsion applied at the rate of 2300 liters per hectare.

Any mulch disturbed or displaced following application shall be removed, reseeded and remulched as specified. Jute netting / Geonetting shall be unrolled and placed parallel to the flow of water immediately following the bringing, to finished grade, the area specified on the plans or the placing of seed and fertilizer. Where more than one strip is required to cover the given areas, they shall overlap a minimum of 100 mm. Jute netting / Geonetting shall be held in place by approved wire staples, pins, spikes or wooden stakes driven vertically into the soil

Maintenance

The Contractor shall maintain all seeded and mulched areas until final acceptance. Maintenance shall include protection of traffic by approved warning signs or barricades and

repairing any areas damaged following the seeding and mulching operations. If mulched areas become damaged, the area shall be reshaped and then seeded and mulched again as originally specified.

Measurement for payment

Seeding and mulching shall be measured as finished work in square metres.

Rate

The Contract unit rate for seeding and mulching shall be payment in full for carrying out all the required operations including full compensation for all materials, labour, tools and incidentals.

Preparation and Surface Treatment of Formation

Preparation and surface treatment of the formation, that is top of the subgrade, shall be carried out only after completion of any specified subgrade drainage and unless otherwise agreed by the Engineer, immediately prior to laying the sub-base or the road base where no sub-base is required. The sequence of operations shall be as follows:

All surfaces below carriageway, lay byes, footways and hard shoulders shall, after reinstatement of any soft areas to the required Specifications be well cleaned and freed of mud and slurry.

The surface shall be compacted by 4 passes of a smooth wheeled roller of 80 to 100 kN weight after spraying requisite amount of water, if required, before the commencement of rolling.

The formation shall, wherever necessary, be regulated and trimmed to the requirements with motor grader.

The trimmed formation shall be rolled by one pass of smooth wheeled roller of 80 to 100 kN weight after spraying requisite amount of water, if required, before the commencement of rolling.

Where the completed formation is not immediately covered with sub base or road base material, its moisture content shall be maintained to prevent cracking in the formation by suitable measures as approved by the Engineer. The entire work of surface treatment of formation shall be deemed as incidental to the work of sub-base / base course to be provided on the subgrade and as such no extra payment shall be made for the same.

Works to be Kept Free of Water

The Contractor shall arrange for the rapid dispersal of water collected / accumulated on the earthwork or completed formation during construction or on the existing roadway or which enters the earthwork or any other item of work from any source, and where practicable, the

water shall be discharged into the permanent outfall of the drainage system. The arrangement shall be made in respect of all earthwork including excavation for pipe trenches, foundations or cuttings.

The Contractor shall provide, where necessary, temporary water courses, ditches, drains, pumping or other means for maintaining the earthwork free from water. Such provisions shall include carrying out the work of forming the cut sections and embankments in such manner that their surfaces have at all times a sufficient minimum crossfall and, where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding.

The works involved in keeping the earthwork or any other item of works free of water shall be deemed as incidental to the respective item of work and as such no separate payment shall be made for the same.

3.23 Gabion Embankment

Gabions are compartmented rectangular containers made of heavily galvanised steel wire, filled with stones, the gabion becomes a large, flexible and permeable building block. Gabions comprises of welded wire mesh panels accurately cut to size with heavy section wire spirals used for interconnecting the edges. The meshes and spirals are pre galvanized with zinc coating of 450 gram per m2. Gabion shall be confirming to ASTM-A974 (Standard Specifications for Welded Wire Fabric Gabions and Gabion Mattresses).

Welded wire mesh is a prefabricated reinforcement consisting of a series of parallel longitudinal wires with accurate spacing welded to cross wires at the required spacing. The welding of the wires is achieved by electric resistance welding with solid state electronic control and all the spacing are controlled by the automatic mechanism of high reliability. There is no foreign metal added at the joint.

The intersecting wires are actually fused into a homogeneous section thereby ensuring permanency of spacing and alignment in either direction. Welded Mesh shall be as per IS:4948 (latest Version). Gabions shall be fabricated in such a manner that the sides, ends, lids and diaphragms can be assembled at the construction site into a rectangular basket of the specified sizes. The basket shall be a single unit construction. In other words, the base, lid and sides shall be woven into a single unit. The ends and diaphragms shall be connected to the base section of the gabion. This connection should be such that strength and flexibility at the point of intersection is at least equal to that of the mesh. Gabion shall be provided minimum 0.5m below ground level.

The boulders shall be hard and shall not deteriorate under water. The section shall be worked out considering 10% porosity with a depth of 1m below the ground to a top level. The slope can be upto 1:0.25. boulder size shall not exceed 200mm.

3.24 Site Filling

3.24.1 Sand fill

Sandy fill shall be deposited to bring the grade level to the desired elevation after compaction of fill. Sandy fill shall be carried out in one of the following methods as detailed in the drawings:

Compaction of sandy fill by flooding the area shall be carried out where so specified. In this case, Contractor should ensure that the fill material is not washed away. This work shall be carried out as directed by Engineer.

Sandy fill shall be compacted where so specified by 12 tonne vibrating rollers. The fill material shall be compacted to the required density.

If the density of fill or use of rollers for compaction is not specified, Contractor shall ensure necessary compaction by the passage of trucks, carrying the fill material over the deposited fill in such a way that the entire fill area is covered. This will reasonably compact the sand fill and will be accepted by Engineer. However, Contractor shall ensure that every layer is thus compacted before the succeeding layers are deposited. Each layer shall not exceed 200mm in thickness.

3.24.2 Soil fill

Approved soil fill consisting of ordinary soil, murrum, soil containing gravel, shingle, etc. shall be deposited in layers not exceeding 200mm. Contractor should ensure that all clods of earth are broken down to a size not larger than 100mm.

Where density of fill or use of rollers is not specified, the fill shall be carried out as specified above.

Where specified, the required density to fill shall be obtained by proper compaction.

3.24.3 Measurement

Measurement shall be made on the basis of Clause 3.13.

End of Chapter-3

CHAPTER – 4

CONCRETE AND ALLIED WORKS

CHAPTER - 4

CONCRETE AND ALLIED WORKS

4.1 Applicable Codes

4.1.1 Materials

1) IS: 269 Specification for Ordinary Portland cement.
2) IS: 455 Specification for Portland slag cement.
3) IS: 1489 Specification for Portland-pozzolana cement (Part 1&2).
4) IS: 12330 Specification for sulphate resisting Portland cement.
5) IS: 383 Specification for coarse and fine aggregates from natural sources for concrete.
6) IS: 432 Specification for mild steel and medium (tensile steel bars and hard-drawn steel) wires for concrete reinforcement. (Part 1 and 2)
7) IS: 1786 Specification for high strength deformed steel bars and wires for concrete reinforcement.
8) IS: 1566 Specification for hard-drawn steel wire fabric for concrete reinforcement.
9) IS: 9103 Specification for admixtures for concrete.
10) IS: 2645 Specification for integral cement water- proofing compounds.
11) IS: 4990 Specification for plywood for concrete shuttering work.

4.1.2 Material Testing

1) IS: 650 Specification for standard sand for testing of cement
2) IS: 2430 Methods for sampling of aggregates for concrete.
3) IS.2386 Methods of test for aggregates for concrete (Parts 1 to 8)
4) IS: 3025 Methods of sampling and test (physical and chemical) for water used in industry.
5) IS.4031 Methods of physical tests for hydraulic cement (Parts 1 to 15)
6) IS: 4032 Method chemical analysis of hydraulic cement.
7) IS: 6925 Methods of test for determination of water soluble chlorides in concrete admixtures.

4.1.3 Material Storage

1) IS: 4082 Recommendations on stacking and storing of construction materials at site.

4.1.4 Concrete Mix Design

1) IS: 10262 Recommended guidelines for concrete mix design.
2) SP: 23 (S&T) Handbook on Concrete Mixes.

4.1.5 Concrete Testing

1) IS: 1199 Method of sampling and analysis of concrete.
2) IS: 516 Method of test for strength of concrete.
3) IS: 9013 Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
4) IS: 8142 Method of test for determining setting time of concrete by penetration resistance.
5) IS: 9284 Method of test for abrasion resistance of concrete.
6) IS: 2770 Methods of testing bond in reinforced concrete.

4.1.6 Equipments

1) IS: 1791 Specification for batch type concrete mixers.
2) IS: 2438 Specification for roller pan mixer.
3) IS: 4925 Specification for concrete batching and mixing plant.
4) IS: 5892 Specification for concrete transit mixer and agitator.
5) IS: 7242 Specification for concrete spreaders.
6) IS: 2505 General Requirements for concrete vibrators: Immersion type.
7) IS: 2506 General Requirements for screed board concrete vibrators.
8) IS: 2514 Specification for concrete vibrating tables.
9) IS: 3366 Specification for pan vibrators.
10) IS: 4656 Specification for form vibrators for concrete.
11) IS: 11993 Code of practice for use of screed board concrete vibrators.
12) IS: 7251 Specification for concrete finishers.
13) IS: 2722 Specification for portable swing weigh batchers for concrete (single and double bucket type).
14) IS: 2750 S Specification for steel scaffoldings.

4.1.7 Codes of Practice

1) IS: 456 Code of practice for plain and reinforced concrete.
2) IS: 457 Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
3) IS: 3370 Code of practice for concrete structures for storage of liquids (Parts 1 to 4)
4) IS: 3935 Code of practice for composite construction.
5) IS: 2204 Code of practice for construction of reinforced concrete shell roof.
6) IS: 2210 Criteria for the design of reinforced concrete shell structures and folded plates.
7) IS: 2502 Code of practice for bending and fixing of bars for concrete reinforcement.
8) IS: 5525 Recommendation for detailing of reinforcement in reinforced concrete works.
9) IS: 2911 Code of practice for Design and construction of Pile foundations. (Part 1 to 4)
10) IS: 9417 Specification for welding cold worked bars for reinforced concrete construction.
11) IS: 3558 Code of practice for use of immersion vibrators for consolidating concrete.
12) IS: 3414 Code of practice for design and installation of joints in buildings.
13) IS: 4326 Code of practice for earthquake resistant design and construction of building.
14) IS: 4014 Code of practice for steel tubular scaffolding (Parts 1 & 2)
15) IS: 2571 Code of practice for laying insitu cement concrete flooring.
16) IS: 7861 Code of practice for extreme weather concreting: Part 1 Recommended practice for hot weather concreting.
17) IRC: 112 Code of practice for Concrete Road Bridges.
18) IRC: 78 Standard Specifications and Code of Practice for Road Bridges.
18) IRC: 21 Standard Specifications and Code of Practice for Road Bridges.
19) IS: 919 Recommendation for limits and fits for engineering.
20) IS: 1597 Construction of Stone Masonry (Part I & II)

4.1.8 Construction Safety

1) IS: 3696 Safety code for scaffolds and ladders. (Parts 1 & 2)
2) IS: 7969 Safety code for handling and storage of building materials.
3) IS: 8989 Safety code for erection of concrete framed structures.

4.1.9 Measurement

1) IS: 1200 Method of measurement of building and Engineering works
2) IS: 3385 Code of practice for measurement of Civil Engineering works

4.2 General

The Engineer shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment and the quality control system. Such an inspection shall be arranged and the Engineer's approval obtained, prior to starting of concrete work. This shall, however, not relieve the Contractor of any of his responsibilities. All materials which do not conform to the Specifications shall be rejected.

Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes/standards shall generally be used. Other materials may be used after approval of the Engineer and after establishing their performance suitability based on previous data, experience or tests.

4.3 Materials

4.3.1 Cement

Unless otherwise called for by the Engineer, cement shall be ordinary Portland cement conforming to IS: 269. Where Portland pozzolana or slag cements are used, it shall be ensured that consistency of quality is maintained, there will be no adverse interactions between the materials and the finish specified is not marred.
Only one type of cement shall be used in any one mix. The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed without approval from the Engineer. Damaged or reclaimed or partly set cement will not be permitted to be used and shall be removed from the site. The storage bins and storage arrangement shall be approved by the Engineer. Consignments of cement shall be stored as received and shall be consumed in the order of their delivery. Storage of cement shall be as per standard practices.

Cement which is not used within 90 days from its date of manufacture shall be tested at a laboratory approved by the Engineer and until the results of such tests are found satisfactory, it shall not be used in any work.

4.3.2 Aggregates (General)

Aggregates shall consist of naturally occurring stones (crushed or uncrushed), gravel and sand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust/silt/ organic impurities/deleterious materials and all characteristics of aggregates conform to IS: 383.

Aggregates such as slag, crushed over burnt bricks, bloated clay ash, sintered fly ash and tiles shall not be used.

Aggregates shall be washed and screened before use where necessary or if directed by the Engineer. Aggregate source shall be approved by BWSSB.

Aggregates containing reactive materials shall be used only after tests conclusively prove that there will be no adverse effect on strength, durability and finish, including long term effects, on the concrete.

The fineness modulus of sand shall neither be less than 2.2 nor more than 3.2.

The maximum size of coarse aggregate shall be as stated on the drawings but in no case greater than 1/4 of the minimum thickness of the member.

Plums 160 mm and above of a reasonable size may be used in mass concrete fill where directed. Plums shall not constitute more than 20% by volume of the concrete.
The natural/ river sand to be used shall be clean, sieved and of good quality. As far as possible natural/ river sand shall be used. Whenever there is scarcity of natural/ river sand, manufactured sand / crushed sand can be used to a maximum extent of 50% of total sand quantity for plastering items and 100% for concrete items. The certification by the concerned Executive Engineer, Quality Control is mandatory for usage of artificial/ manufactured sand.

All coarse and fine aggregates shall be stacked separately in stock piles in the material yard near the work site in bins properly constructed to avoid inter mixing of different aggregates. Contamination with foreign material and earth during storage and while heaping the materials shall be avoided. The aggregates must be of specified quality not only at the time of receiving at site but more so at the time of loading into mixer. Rakers shall be piled in layers not exceeding 1.20 m in height to prevent coning or segregation. Each layer shall cover the entire area of stockpile before succeeding layers are started. Aggregates that have become segregated shall be rejected.

4.3.3 Water

Water used for both mixing and curing shall conform to IS: 456. Potable waters are generally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used. Contractor shall also use treated water being sold by BWSSB, to end exploitation of ground water.

4.3.4 Reinforcement

In general, reinforcement shall conform to TMT-CRS-500 and other reinforcement bars shall conform to IS: 432 or IS: 1786 and welded wire fabric to IS: 1566 as shown or specified on the drawing.

All reinforcement shall be clean, free from pitting, oil, grease, paint, loose mill scales, rust, dirty, dust, or any other substance that will destroy or reduce bond.

4.3.5 Admixtures

Accelerating, retarding, water-reducing and air entraining admixtures shall conform to IS: 9103 and integral water proofing admixtures to IS: 2645.

Admixtures may be used in concrete as per manufacturer's instructions only with the approval of the Engineer. An admixture's suitability and effectiveness shall be verified by trial mixes with the other materials used in the works. If two or more admixtures are to be used simultaneously in the same concrete mix, their interaction shall be checked and trial mixes done to ensure their compatibility. There should also be no increase in risk of corrosion of the reinforcement or other embedment.

Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted such as in mass concrete works, it shall be dissolved in water and added to the mixing water by an amount not exceeding 1.5 percent of the weight of the cement in each batch of concrete. The designed concrete mix shall be corrected accordingly.

4.3.5.1 Air Entraining Agents

Neutralized Vinson resin or other approved air in the concrete mix agents shall conform to the requirements of ASTM standard 6.260; Air Entraining Admixtures for Concrete. The recommended total air content of the concrete is 4% + 1%. The method of measuring air content shall be as per IS: 1199.

4.3.5.2 Water Reducing Admixtures

Water reducing lignosulfonate admixture may be added in quantities approved by the Engineer. The admixtures shall be added in the form of a solution.

4.3.5.3 Retarding Admixtures

Retarding agents may be added to the concrete mix in quantities approved by the Engineer.

4.3.5.4 Water Proofing Agent

Water proofing agents shall conform to IS: 2645.

4.3.5.5 Other Admixtures

The Engineer may at his discretion allow the contractor to use any other admixture in the concrete.

4.4 Wastage

Wastage allowance for cement and steel and higher rolling margin for steel shall be considered in the item rate and no extra payment shall become payable to the Contractor on any account.

4.5 Samples and Tests

All materials used for the works shall be tested before use. Manufacturer's test certificate shall be furnished for each batch of cement/steel and when directed by the Engineer samples shall also be got tested by the Contractor in a laboratory approved by the Engineer at no extra cost to Employer. Sampling and testing shall be as per IS: 2386 under the supervision of the Engineer. Water to be used shall be tested to comply with requirements of IS: 456.

The Contractor shall furnish manufacturer's test certificates and technical literature for the admixture proposed to be used. If directed, the admixture shall be got tested at an approved laboratory at no extra cost.

4.6 Storing of Materials

All materials shall be stored in a manner so as to prevent its deterioration and contamination which would preclude its use in the works. Requirements of IS: 4082 shall be complied with.

The Contractor will have to make his own arrangements for the storage of adequate quantity of cement. If such cement is not stored properly and has deteriorated, the material shall be rejected. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Not more than 15 bags shall be stacked in any tier. Storage arrangement shall be approved by the Engineer. Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order of receipt.

Each size of coarse and fine aggregates shall be stacked separately and shall be protected from leaves and contamination with foreign material. The stacks shall be on hard, clean, free draining bases, draining away from the concrete mixing area.

The Contractor shall make his own arrangements for storing water at site in tanks to prevent contamination.

The reinforcement shall be stacked on top of timber sleepers to avoid contact with ground/water. Each type and size shall be stacked separately.

4.7 Concrete

4.7.1 General

Concrete grade shall be as designated on drawings. In concrete grade M15, M20 etc. the number represents the specified characteristic compressive strength of 150 mm cube at 28 days, expressed in N/sq.mm as per IS:456. Concrete in the works shall be "DESIGN MIX CONCRETE" or "NOMINAL MIX CONCRETE". All concrete works of grade M10 and M15 shall be NOMINAL MIX CONCRETE whereas all other grades, M20 and above, shall be DESIGN MIX CONCRETE.
The grades of concrete to be used are noted on the drawings. In addition, the following table shall apply unless specified otherwise.

Structure	Grade of Concrete	Max. Aggregate Size
1. All Liquid retaining structures / Wet wells/ Bridges/ Piles/ Pile caps	M30	20 mm
2. Sewage Pumping Stations/ Buildings		
(a) for foundation raft	M25	20 mm
(b) for walls, columns, floor beams, circular floor slab	M25	20 mm
(c) for beams, slabs etc.	M25	20 mm
3. Valve chambers		
(a) for foundation raft	M25	20 mm
(b) walls, columns	M25	20 mm
(c) for slabs, beams, etc.	M25	20 mm
4. Anchor blocks/ Thrust blocks/ Antiflotation blocks	M20	40 mm
5. Saddles	M25	20 mm
6. Pipeline encasement, grade slab, ramps, footings under walls, SW drain coping etc	M20	20 mm
7. Bridges		
Foundation of piers and abutments	M30	20 mm
Piers and abutments with wing walls	M30	20 mm
Hammer head of pipes	M30	20 mm
8. Causeway	M25	20 mm
9. Machine holes	M30	20 mm

4.7.2 Controlled Concrete

All concrete in the works shall be “Controlled Concrete” as defined in IS: 456 except for M-10 for which normal mix concrete shall be used.

Note: It shall be very clearly understood that whenever the grade of concrete such as M-20, etc. is specified it shall be contractor’s responsibility to ensure the minimum crushing strength stipulated for the respective grade of concrete is obtained at works.

4.7.3 Design Mix Concrete

4.7.3.1 Mix Design & Testing

For Design Mix Concrete, the mix shall be designed according to IS: 10262 and SP: 23 to provide the grade of concrete having the required workability and characteristic strength not less than appropriate values given in IS: 456. The design mix shall in addition be such that it is cohesive and does not segregate and should result in a dense and durable concrete and also capable of giving the finish as specified. For liquid retaining structures, the mix shall also result in water tight concrete. The Contractor shall exercise great care while designing the concrete mix and executing the works to achieve the desired result based on SP23 Fig 37 of minimum cement paste volume in concrete for durability.

The minimum cement content for Design Mix Concrete shall be as per Table-5 of IS: 456 and for Pile foundations as per IS: 2911 or as given below, whichever is higher.

Grade of Concrete	Minimum Cement Content in Kg/Cu.m of Concrete
M20	320
M25	360
M30	400

The minimum cement content stipulated above shall be adopted irrespective of whether the Contractor achieves the desired strength with less quantity of cement. The Contractor's quoted rates for concrete shall provide for the above eventuality and nothing extra shall become payable to the Contractor in this account. Even in the case where the quantity of cement required is higher than that specified above to achieve desired strength based on an approved mix design, nothing extra shall become payable to the Contractor.

The Contractor shall submit details of the source of all material and the proposed quantities of each ingredient per cubic metre of fully compacted concrete. The Contractor shall then make trial mixes for each class of concrete using the same Contractor's Equipment and the same materials as are proposed for the Permanent Works. The Contractor shall give 24 hours notice of such trials to enable the Engineer's Representative to attend. For each trial mix, three separate batches of concrete shall be made by the Contractor and will be tested at 28 days all in accordance with IS: 516. Such trial mixes shall not be the first batch through the plant in any one sequence of concrete production.

The Contractor shall not commence concreting in the Permanent Works until details of trial mixes and test results for each class of concrete have been submitted to and approved by the Engineer.

Unless otherwise specified, only medium graded fine aggregate shall be used.
A trial mix design will be approved by the Engineer with respect to strength if the average compressive strength of the nine cubes so tested is more than the target means strength appropriate to the grade of concrete.

For concrete of Grade 30 and over the Contractor shall cast two sample wall panels 48 hours apart. Each shall be cast in two equal lifts to form a wall panel having one horizontal construction joint formed in the manner proposed by the Contractor for the Works. The top surface of the second lift shall have a Type U3 finish. The panels shall not be touched up after stripping. The panels shall be 300 mm thick and 1.5 m long by 1.5 m high. The Contractor shall not commence concreting in the Permanent Works until the test panels have been approved by Engineer.

The Contractor shall not alter the approved mix proportions or the approved source of supply of any of the ingredients without having previously obtained the approval of the Engineer.
During production, the Engineer may require trial mixes to be made before a substantial change is made in the materials or in the proportions of the materials to be used.
It shall be the Contractor's sole responsibility to carry out the mix designs at his own cost. He shall furnish to the Engineer at least 30 days before concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS:516 shall comply with the requirements of Clause 16 of IS:456.

A range of slumps which shall generally be used for various types of construction unless otherwise instructed by the Engineer is given below:

4.7.3.2 Workability

The workability of concrete shall be checked at frequent intervals by slump test. Where facilities exist and if required by the Engineer, alternatively the compacting factor test in accordance with IS: 1199 shall be carried out. The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of form work and round the reinforcement to give the required surface finish shall depend on the type and nature of the structure and shall be based on experience and tests

4.7.3.3 Workmanship

All workmanship shall be according to the latest relevant standards. Before starting a pour the contractor shall obtain the approval of the Engineer in a "Pour Card" maintained for this purpose. He shall obtain complete instructions about the material and proportion to be used, slump, workability of water per unit of cement, number of test cubes to be taken, finishing to be done and any admixture to be added etc

Structure/Member	**Slump in millimeters**	
	Maximum	**Minimum**
Reinforced foundation walls and footings	75	40
Plain footings, caissons and substructure walls	75	40
Slabs, Beams and reinforced walls	100	50
Pump & miscellaneous Equipment Foundation	75	40
Building columns	100	40
Pavements	50	40
Heavy mass construction	50	40

Note: All concreting done for water retaining structures shall have a minimum slump value of 80 mm and maximum of 100 mm

4.7.3.4 Batching & Mixing of Concrete

It is expected that batching plants of minimum 30 m^3 capacity, with two silos and pumps for placing concrete shall be used. Proportions of aggregates and cement, as decided by the concrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable of controlling the weights within one percent of the desired value.

Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water- cement ratio specified for use by the Engineer shall be maintained. Each time the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional cement to allow for sticking in the drum.

Arrangement should be made by the Contractor to have the cubes tested in an approved laboratory or in field with prior consent of the Engineer. Sampling and testing of strength and workability of concrete shall be as per IS: 1199, IS: 516 and IS: 456.

4.7.4 Nominal Mix Concrete

4.7.4.1. Mix Design & Testing

Mix design and preliminary tests are not necessary for Nominal Mix Concrete. However, works tests shall be carried out as per IS: 456. Proportions for Nominal Mix Concrete and w/c ratio may be adopted as per Table 9 of IS: 456. However, it will be the Contractor's sole responsibility to adopt appropriate nominal mix proportions to yield the specified strength.

4.7.4.2. Batching & Mixing of Concrete

Based on the adopted nominal mixes, aggregates shall be measured by volume. However cement shall be by weight only, using whole bags of cement.

4.8 Formwork

Formwork shall be all inclusive not be limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs etc. including ties, anchors, hangers, inserts, falsework, wedges etc.

The design and engineering of the formwork as well as its construction shall be the responsibility of the Contractor. However, if so desired by the Engineer, the drawings and calculations for the design of the formwork shall be submitted to the Engineer for approval.

Formwork shall be designed to fulfill the following requirements:

1. Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.

2. Made of suitable materials.

3. Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.

4. Capable of withstanding without deflection the worst combination of selfweight, reinforcement and concrete weight, all loads and dynamic effects arising from construction and compacting activities, wind and weather forces.

5. Capable of easily striking without shock, disturbance or damage to the concrete.

6. Soffit forms capable of imparting a camber if required.

7. Soffit forms and supports capable of being left in position if required.

8. Capable of being cleaned and/or coated if necessary immediately prior to casting the concrete. design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.

The formwork may be of timber, plywood, steel, plastic or concrete depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of the Engineer. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and formwork and between formwork and structures shall be sufficiently tight to prevent loss of slurry from concrete, using seals if necessary.

The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, shavings, sawdust, wire pieces dust etc. shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air at no extra cost.

Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of the Engineer. The Contractor shall equip himself with enough shuttering to allow for wastage so as to complete the job in time.

Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete.

Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves shall be used. Formwork spacers left insitu shall not impair the desired appearance or durability of the structure by causing spalling, rust staining or allowing the passage of moisture.

For liquid retaining structures, sleeves shall not be provided for through bolts nor shall through bolts be removed if provided. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

All corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size, except where specified in the drawings.

Forms for substructure may be omitted when, in the opinion of the Engineer, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavations shall be larger, as approved by the Engineer, than that required as per drawing to compensate for irregularities in excavation.

The Contractor shall provide adequate props carried down to a firm bearing without overloading any of the structures.

The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering for a column is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.0m or as approved by the Engineer. The Contractor shall temporarily and securely fix items to be cast (embedment's/ inserts) in a manner that will not hinder the striking of forms or permit loss of grout.

Formwork showing excessive distortion, during any stage of construction, shall be repositioned and strengthened. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete at Contractor's cost.

The striking time for formwork shall be determined based on the following requirements:

(a) Development of adequate concrete strength;
(b) Permissible deflection at time of striking form work;
(c) Curing procedure employed - its efficiency and effectiveness;
(d) Subsequent surface treatment to be done;
(e) Prevention of thermal cracking at re-entrant angles;
(f) Ambient temperatures; and

(g) Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).

Under normal circumstances (generally where temperatures are above 20°C) forms may be struck after expiry of the time period given in IS: 456 unless approved otherwise by the Engineer. For Portland Pozzolana/slag cement the stripping time shall be suitably modified as approved by the Engineer. It is the Contractor's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resist surface damage and any stresses arising during the construction period.

4.9 Removal of Formwork

Formwork shall be so designed as to permit any removal without resorting to hammering or levering against the surface of the concrete. The periods of time elapsing between the placing of the concrete and the striking of the loads likely to be imposed on the concrete and shall in any case be not less than the periods, shown in Table below. Where soffit formwork is constructed in a manner during and after such removal of a sufficient number of adequate supporting props in an undisturbed condition, the Contractor may, with the agreement of the Engineer, remove the formwork at the earlier times listed below provided that the props are left in position.

Table 12

Position of Formwork	Days for Striking
Walls	1
Sides of beams and columns	1
Slabs (Drops left under)	3
Props to slabs (span not exceeding 4.5m)	7
Props to slabs (span exceeding 4.5 m)	14
Beams soffits (props left under)	21

Not withstanding the foregoing, the Contractor shall be held responsible for any damage arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading.

Striking shall be done slowly with utmost care to avoid damage to projections and without shock or vibration, by gently easing the wedges. If after removing the form work it is found that timber has been embedded in the concrete. It shall be removed and made good as specified earlier.

Reinforced temporary openings shall be provided, as directed by the Engineer, to facilitate removal of formwork which otherwise may be inaccessible.

The rods, clamps, form bolts, etc. which must be entirely removed from walls or similar structures shall be loosened not sooner than 24 hours not later than 40 hours after the concrete has been deposited. Ties, except those required to hold forms in place, may be removed at the same time. Ties, withdrawn from walls and grade beams shall be pulled toward the inside face. Cutting ties back from the faces of the walls and grade beams will not be permitted.

4.10 Technical Specifications for Sheet Piling

4.10.1 General

Sheet piling is a form of driven piling using interlocking sheets of steel to obtain a continuous barrier in the ground. The main application of sheet pile is in retaining walls erected for the purpose of excavation to enable permanent works to proceed. Normally vibrating hammer/ impact hammer, crane and crawler drilling are to be used to establish sheet piles. The work shall be done as per BOQ provisions. The work shall include supply, installation and subsequent removal of all miscellaneous steel shapes, plates and connecting hardware when required to attach the sheeting to an existing substructure unit and/or facilitate stage construction.

All initial banking has to be formed at contractor's own cost for taking the machinery to drive the sheet piles. The area shall be filled driving of steel sheet piles with pit sand for leveling the ground.

Piles shall be driven, true to plumb and alignment. Hammer for sheet pile driving shall be drop hammer, steam hammer, air hammer, diesel hammer or vibratory hammer. Sheet pile driving shall commence initially with minimum impact of hammer, which can be increased later after ensuring that the piles are being driven vertically through the interlocking grooves along with designed alignment. The sheet piles are to be driven with batten welded at suitable intervals. The Steel Sheet Pile may be lifted at single point

4.10.2 Applicable Code

All work shall be carried out strictly in accordance with the Technical Specifications, unless otherwise approved by Engineer in writing. The Indian Standard Codes applicable to this section shall include but not limited to the following.

IS 2314:1986 Specification for steel sheet piling sections (first revision)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 6/A 6M (2000) General Requirements for Rolled Structural Steel Bars,

Plates, Shapes, and Sheet Piling

ASTM A 328/A 328M (200) Steel Sheet Piling

ASTM A 572/A 572M (200) High-Strength Low-Alloy Columbium-Vanadium

Structural Steel

ASTM A 690/A 690M (1994) High-Strength Low-Alloy Steel H-Piles and

Sheet Piling for Use in Marine Environments

ASTM A 857/A 857M (1997el) Steel Sheet Piling, Cold Formed, Light Gage.

4.10.3 Transportation

The Contractor shall set up, in accordance with the construction schedule make all the necessary arrangements for hauling of all materials for the steel sheet pile driving so that all the materials will be available for immediate use whenever required:

a) All the steel sheet piles shall be delivered intact at the site without causing any permanent distortion in the member or injury or deformation at joints.

b) Care shall be taken in handling such materials as tie-rods to avoid damage to the thread and shop coat painting.

c) Handling of such long members as walling shall be carried out in the same way as for the steel sheet piles.

4.10.4 Storage

a) Storage space for steel sheet piles shall be reasonably leveled and compacted. The site so selected should be got approved by the ENGINEER.

b) Steel sheet piles shall be stacked in such a way as to avoid strain or distortion in the materials.

c) Steel sheet piles shall be stacked up in such tiers as each consisting of not more than 3 piles, and between each tier wooden sleepers shall be inserted at intervals not exceeding 4m. Total height of stack shall not exceed 2m.

d) Tie-rods and accessories shall be sorted, stacked in accordance with their diameters and shall be stored under cover and not be directly exposed to weather.

e) The Contractor shall be responsible for safe handling, mobilization & demobilization and storage of piles and other materials. The rate for sheet pile driving shall include the cost for handling and storage of piles and other accessories, forming driving pit, formation and removal of earthen bund if required, all other requisites for successful driving of sheet pile.

4.10.5 Cutting of Sheet Pile

a) Cutting of steel sheet piles shall be done by means of a gas cutting device.

b) Steel sheet piles to be cut shall be free from curve and warp, and securely clamped on a level work table for cutting.

c) Use of a special jig is desirable to minimize deformation due to cutting

d) Whatever method is used in cutting, a certain degree of deformation is bound to occur. If the deformation is less than 40mm, it can be set right by hammering or by heat treatment to the deformed segment. If the deformation exceeds the above range, mechanical correction by means of jacks and press shall be made.

4.10.6 Sheet Pile Welding

a) Arc welding shall be adopted for steel sheet pile work.

b) Only skilled welders approved by the ENGINEER shall be engaged for the work.

c) Welding equipment shall be AC rectifiers / arc-welding unit. Welding rods shall be those conforming to the relevant IS or equivalent and subject to prior approval of ENGINEER.

d) If any welding is rejected by the ENGINEER, the Contractor shall perform the welding again by cutting off at the weld at his cost. All the costs thereof shall be borne by the Contractor.

4.10.7 Materials

Metal sheet piling material shall be conforming to IS:2314 or equivalent ASTM standards. The interlocks of sheet piling shall be free-sliding, provide a swing angle suitable for the intended installation but not less than 5 degrees when interlocked, and maintain continuous interlocking when installed. Sheet piling [including special abricated sections] shall be [full-length] sections of the dimensions as shown in the drawing. Sheet piling shall be provided with standard pulling holes.

Metal plates, shapes, bolts, nuts, rivets, and other appurtenant fabrication and installation materials shall conform to manufacturer's standards and to the requirements specified in the respective sheet piling.

4.10.8 Extraction of Rejected Sheet Pile:

If the pile driving work has not been done to the specification, the Contractor shall extract the rejected pile. The extraction shall be such as to avoid damages to the adjoining piles, other structures and installations. Cost of extraction and replacement shall be borne by the Contractor.

4.10.9 Construction

The Contractor shall verify locations of all underground utilities before driving any sheet piling. Any disturbance or damage to existing structures, utilities or other property, caused by the Contractor's operation, shall be repaired by the Contractor in a manner satisfactory to the Engineer at no additional cost to the Department. The Contractor shall be responsible for determining the appropriate equipment necessary to drive the sheeting to the tip elevation(s) specified on the plans or according to the Contractor's approved design. The Contractor shall be responsible for determining the appropriate equipment necessary to drive the sheeting to the tip elevation(s) specified on the plans or according to the Contractor's approved design. The sheet piling shall be driven, as a minimum, to the tip elevation(s) specified, prior to commencing any related excavation. If unable to reach the minimum tip elevation, the adequacy of the sheet piling design will require re-evaluation by the PMC/ Owner prior to allowing excavation adjacent to the sheet piling in question. The Contractor shall not excavate below the maximum excavation line shown on the plans without the prior permission of the Engineer. The sheet piling shall remain in place until the Engineer determines it is no longer required.

The sheet piling shall be removed and take away from site by the Contractor when directed by the Engineer. When allowed, the Contractor may elect to cut off a portion of the sheet piling leaving the rest in place. The remaining piling shall be a minimum of 12 in. (300 mm) below the finished grade or as directed by the Engineer. Removed sheet piling becomes the property of the Contractor. When an obstruction is encountered, the Contractor shall notify the Engineer and upon concurrence of the Engineer, the Contractor shall begin working to break up, push aside, or remove the obstruction. An obstruction shall be defined as any object (such as but not limited to, boulders, logs, old foundations etc.) where its presence was not obvious or specifically noted on the plans prior to bidding, that cannot be driven through or around with normal driving procedures, but requires additional excavation or other procedures to remove or miss the obstruction.

The following are the installation procedures:

1 The alignment of sheet pile wall shall be correctly set up for the approval of the ENGINEER before commencing the sheet pile driving.

2 Guide frames and stakes shall be installed correctly and secured properly to ensure driving of piles on the centre line.

3 Steel sheet pile driving shall be performed by one of the following methods.

a) In driving single pile one by one, special care shall be exercised to keep each pile penetrating in strictly vertical direction.

b) In driving a group of piles (about 20 pieces simultaneously) a guide frame shall be used to keep them in a straight alignment, and in the initial stage all the piles shall be driven to a depth just enough to enable them to stand in positions. Then one or two pieces on both ends shall be driven down first, followed by the intermediate piles which shall be driven alternately in several stages to final level.

4 Prior to starting pile driving, the Contractor shall submit the driving method and time schedule for approval of the ENGINEER and in accordance with the sequence approved by the ENGINEER. The piles shall be driven vertically in the specified positions.

5 Pile driving:

a) Sheet pile driving shall commence initially with minimum impact of hammer and increased later after ensuring that the piles are being driven vertically in designed alignment.

b) Pile shall be driven with cap and cushion on top of the pile for protection against the impact of drop hammer.

c) Lengthening of pile, if required, shall be done by welding additional piece on to the top of pile already driven. The joints shall be as strong as the normal section of the pile.

d) In case interlocks of piles with adjacent ones are found loosened or dislocated during or after driving, such piles shall be pulled out and replaced with new ones or redone otherwise in accordance with instructions of the ENGINEER.

e) The Contractor shall take every step to ensure safety and to prevent accident while handling and driving piles. If any deviation from specified lines, fractured top, deficient or excessive penetration is observed during pile driving, the driving shall be suspended to take corrective measures as directed by the ENGINEER.

f) Necessary data and logs such as of the number of blows, length of penetration etc. during sheet pile driving shall be made and submitted in duplicate to the ENGINEER at no extra cost. Format of driving log shall be got approved by ENGINEER prior to commencement of driving sheet piles.

6 Reformed steel sheet piles:

a) Reformed steel sheet piles shall be of three types, namely corner sheet pile, junction sheet pile and wedge sheet pile.

b) Corner sheet piles are used where centre line for driving turns to form an angle, and joined by welding to the sheet pile wall that has changed its direction.

c) Junction sheet piles are those to be used where two walls of sheet piles meet at right angle forming a T junction, and where the sizes of sheet pile change along the same line.

d) Wedge sheet piles are used to make up for the deviation of piles from the plumb line caused during driving. This type of pile is characterized by its wedge like shape, tapering downward to the tip.

e) Reformed steel sheet piles as mentioned above shall as a rule is manufactured in a factory. If it becomes inevitable to fabricate them in the field at site, the Contractor shall provide equipment and manufacturing means equivalent to those of the regular factory production and have close supervision and control over driving.

f) If the Contractor finds it necessary to use the reformed steel sheet piles, he shall obtain approval of the ENGINEER for the use, and fabricate the same at his own cost in accordance with the instructions of the ENGINEER.

4.10.10 Payment for Steel Sheet Piling

It may be noted that the measurement shall be taken for one side of the trench only and the Contractor shall be paid for one side only even though sheet pilling work is provided for both sides trench in accordance with the Contract drawings or as directed by the Engineer. The unit rate for steel sheet pile driving shall include the costs of material, transportation, driving and incidental costs towards

replacement of the damaged steel sheet piles. The cost will also include the cost of waling and accessories.

4.11 Reinforcement Workmanship

Reinforcing bars supplied bent or in coils shall be straightened cold without damage. No bending shall be done when ambient temperature is below 5°C. Local warming may be permitted if steel is kept below 100° C.

All bars shall be accurately bent gradually and according to the sizes and shapes shown on the drawings/ schedules or as directed by the Engineer.
Re-bending or straightening incorrectly bent bars shall not be done without the approval of the Engineer.

Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire etc. to prevent displacement during placing and compaction of concrete. The tied in place reinforcement shall be approved by the Engineer prior to concrete placement. Spacers shall be of such materials and designs as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover.

Binding wire shall be 16 gauge soft annealed wires. Ends of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.
Substitution of reinforcement, laps/splices not shown on drawing shall be subject to Engineer's approval.

4.12 Tolerances

Tolerance is a specified permissible variation from lines, grade or dimensions given in drawings. No tolerance specified for horizontal or vertical building lines or footings shall be construed to permit encroachment beyond the legal boundaries. Tolerance for formed and concrete dimensions shall be as per IS:456 unless specified otherwise.

4.12.1 Tolerances for R.C. Buildings

Variation from the Plumb

(i) In the lines and surfaces of columns, piers, walls and in arrises 5 mm per 2.5 m or 25 mm, whichever is less.

(ii) For exposed corner columns and other conspicuous lines

In any bay or 5 m maximum	-	5 mm
In 10 m or more	-	10 mm

Variation from the level or from the grades indicated on the drawings

(i) In slab soffits, ceilings, beam soffits, and in arises

In 2.5 m	-	5 mm
In any bay or 5 m maximum	-	10 mm
In 10 m or more	-	15 mm

(ii) For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines :

In any bay or 5 m maximum	-	5 mm
In 10 m or more	-	10 mm

Variation of the linear building lines from established position in plan and related position of columns, wall and partitions :

In any bay or 5 m maximum	-	10 mm
In 10 m or more	-	20 mm

Variation in the sizes and locations of sleeves, openings in walls and floors – 5 mm except in the case anchor bolts.

Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls

Minus - 5 mm
Plus - 10 mm

Footings

(i) Variation in dimension in plan
Minus - 5 mm
Plus - 50 mm

(ii) Misplacement or eccentricity
2% of footing width in the direction of misplacement but not more than 50 mm

(iii) Reduction in thickness
Minus - 5% of specified thickness subject to a maximum of 50 mm

Variation in steps

(i) In a flight of stairs
Rise - 3 mm
Tread - 5 mm

(ii) In consecutive steps
Rise - 1.5 mm
Tread - 3.0 mm

4.12.2 Tolerances in other structures

All structures

(i) Variation of the construction linear outline from established position in plan
In 5 m - 10 mm
In 10 m or more - 15 mm

(ii) Variations of dimensions to individual structure features from established positions
In 20 m or more - 25 mm
In buried construction - 50 mm

(iii) Variation from plumb, from specified batter or from curved surfaces of all structures
In 2.5 m - 10 mm
In 5 m - 15 mm
In 10 m or more - 25 mm
In buried construction - Twice the above amounts

(iv) Variation from level or grade indicated on drawings in slab, beams, soffits, horizontal grooves and visible arises.
In 2.5 m - 5 mm
In 7.5 m or more - 10 mm
In buried construction - Twice the above amounts

(iv) Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members
Minus - 5 mm
Plus - 10 mm

(vi) Variation in the thickness of slabs, walls, arch sections and similar members
Minus - 5 mm
Plus - 10 mm

Footing for columns, piers, walls, buttresses and similar members

(i) Variation of dimension in plan
Minus - 10 mm
Plus - 50 mm

(ii) Misplacement or eccentricity
2% footing width in the direction of misplacement but not more than 50 mm

(iii) Reduction in thickness
5% of specified thickness subject to a maximum of 50 mm.

Tolerance in fixing anchor bolts shall be as follows:

(i) Anchor bolts without sleeves	:	1.5 mm in plan
(ii) Anchor bolts with sleeves	:	5.0 mm in elevation
- for bolts upto and including 28 mm dia	:	5 mm in all directions
- for bolts 32 mm dia and above	:	3 mm in all directions
(iii) Embedded parts	:	5 mm in all directions

4.12.3 Tolerances in Formwork:

The formwork shall be designed and constructed to the shapes, lines and dimensions shown on the drawings within the tolerances given below:

(i)	Deviation from specified dimensions of cross section of columns and beams	- 6 mm + 12 mm
(ii)	Deviations from dimensions of footings (Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel or dowels)	
	- Dimension in plan	- 12 mm + 50 mm
	- Eccentricity	0.02 times the width of the footing in the direction of deviation but not more than 50 mm
	- Thickness	± 0.05 times the specified thickness

4.13 Preparation Prior to Concrete Placement

Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. provided.

All arrangements-formwork, equipment and proposed procedure, shall be approved by the Engineer. Contractor shall maintain separate Pour Card for each pour as per the format enclosed.

4.14 Transporting, Placing and Compacting Concrete

Concrete shall be transported from the mixing plant to the formwork with minimum time lapse by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water.

In all cases concrete shall be deposited as nearly as practicable directly in its final position. To avoid segregation, concrete shall not be rehandled or caused to flow. For locations where direct placement is not possible and in narrow forms the Contractor shall provide suitable drops and "Elephant Trunks". Concrete shall not be dropped from a height of more than 1.0m.
Concrete shall not be placed in flowing water. Under water, concrete shall be placed in position by tremies or by pipeline from the mixer and shall never be allowed to fall freely through the water.

While placing concrete the Contractor shall proceed as specified below and also ensure the following:

1. Continuously between construction joints and pre- determined abutments.
2. Without disturbance to forms or reinforcement.

3. Without disturbance to pipes, ducts, fixings and the like to be cast in; ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits etc.
4. Without dropping in a manner that could cause segregation or shock.
5. In deep pours only when the concrete and formwork designed for this purpose and by using suitable chutes or pipes.
6. Do not place if the workability is such that full compaction cannot be achieved.
7. Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting if necessary. In supported excavations, withdraw the linings progressively as concrete is placed.
8. If placed directly onto hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.
9. Ensure that there is no damage or displacement to sheet membranes.
10. Record the time and location of placing structural concrete.
11. Cover blocks of required size depending on the cover of the reinforcement as mentioned in the drawings should be prepared in 1:3 cement mortar with fine aggregates.
12. The top surface of each pour and bedding planes shall be approximately horizontal unless otherwise instructed. Top layer should be rough and with key for further extension of work.
13. Concrete shall be compacted during placing with approved vibrating equipment until the concrete has been consolidated to the maximum practicable density, as specified in the IS, is free of pockets of coarse aggregate and fits tightly against all form surfaces, reinforcement and embedded fixtures.
14. Vibrators shall conform to BIS specifications. Type of vibrator to be used shall depend on the structures where concrete is to be placed.
15. Bleeding or free water on top of concrete being deposited into the forms, shall be the cause to stop the concrete pour and the conditions causing this defect corrected before any further Concreting is resumed.

Concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork.

Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly till air bubbles cease to come to the surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers.

Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set. Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure approved by the Engineer. The slump shall be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

Except when placing with slip forms, each placement of concrete in multiple lift work, shall be allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction, and it shall be resumed before concrete takes initial set but not until it has had time to settle as approved by the Engineer. Concrete shall be protected against damage until final acceptance.

4.15 Mass Concrete Works

Sequence of pouring for mass concrete works shall be as approved by the Engineer. The Contractor shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

4.16 Curing

Curing and protection shall start immediately after the compaction of the concrete to protect it from:

1. Premature drying out, particularly by solar radiation and wind
2. Leaching out by rain and flowing water
3. Rapid cooling during the first few days after placing
4. High internal thermal gradients
5. Low temperature or frost
6. Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

All concrete, unless approved otherwise by the Engineer, shall be cured by use of continuous sprays or ponded water or continuously saturated coverings of sacking, canvas, hessain or other absorbent material for the period of complete hydration with a minimum of 7 days. The quality of curing water shall be the same as that used for mixing.
Where a curing membrane is approved to be used by the Engineer, the same shall be of a non-wax base and shall not impair the concrete finish in any manner. The curing compound to be used shall be approved by the Engineer before use and shall be applied with spraying equipment capable of a smooth, even textured coat.

Curing may also be done by covering the surface with an impermeable material such as polyethylene, which shall be well sealed and fastened.

4.17 Construction Joints and Keys

Construction joints will be as shown on the drawing or as approved by the Engineer. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made with the approval of the Engineer.

Dowels for concrete work, not likely to be taken up in the near future, shall be coated with cement slurry and encased in lean concrete as indicated on the drawings or as approved by the Engineer.

As soon as the exposed concrete has sufficiently hardened, the surface of the joint shall be water jetted or brushed with a stiff brush to expose the larger aggregate without being disturbed. Roughening of the surface by chipping or hacking will not generally be approved. Before placing fresh concrete against a construction joint all loose material shall be removed and the surface sluiced with water until it is perfectly clean, thereafter all ponded water should be removed.

When concreting is to be resumed on a surface which has not fully hardened, all laitance shall be removed by wire brushing, the surface wetted, free water removed and a coat of cement slurry applied. On this, a layer of concrete not exceeding 150 mm thickness shall be placed and well rammed against the old work. Thereafter work shall proceed in the normal way.

4.18 Movement Joints

1. Movement joints are defined as all joints intended to accommodate relative movement between adjoining parts of a structure, special provision being made where necessary for maintaining the water tightness of the joint. The contractor shall comply with the instructions

of manufacturers of proprietary jointing materials and shall, if required by the Engineer, demonstrate that the jointing materials can be applied satisfactorily.

2. The surface of set concrete in a movement joint shall, as shown on the drawings, be painted with two coats of bituminous paint and new concrete shall be placed against it only when the paint is dry. Expansion joints shall be formed by a separating strip of approved preformed joint filler.
3. 3. Caulking grooves shall be provided. At all joints where a caulking groove is formed, immediately prior to caulking, the groove shall be wire brushed and loose material removed and blown out by compressed air. After the groove has dried, it shall be primed and caulked with approved sealing compound applied in accordance with the manufacturer's instructions. At all caulked joints, the face of the caulking strip and a width of concrete on either side shall be painted with two coats of paint having the same base as the sealing compound.

4.19 Foundation Bedding

All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft or spongy areas shall be cleaned out and back filled with either soil-cement mixture, lean concrete or clean sand compacted as approved by the Engineer. The surfaces of absorptive soils shall be moistened.

Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form rough steps or benches by picking, barring or wedging. The rock surface shall be kept wet for 2 to 4 hours before concreting.

4.20 Finishes

4.20.1 General

The formwork for concrete works shall be such as to give the finish as specified. The Contractor shall make good any unavoidable defects as approved consistent with the type of concrete and finish specified; defects due to bad workmanship (e.g. damaged or misaligned forms, defective or poorly compacted concrete) will not be accepted. The Contractor shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

4.20.2 Surface Finish Type F1

The main requirement is that of dense, well compacted concrete. No treatment is required except repair of defective areas, filling all form tie holes and cleaning up of loose or adhering debris. For surfaces below grade which will receive waterproofing treatment the concrete shall be free of surface irregularities which would interfere with proper and effective application of waterproofing material specified for use.

4.20.3 Surface Finish Type F2

The appearance shall be that of a smooth dense, well- compacted concrete showing the slight marks of well fitted shuttering joints. The Contractor shall make good any blemishes.

4.20.4 Surface Finish Type F3

This finish shall give an appearance of smooth, dense, well-compacted concrete with no shutter marks, stain free and with no discolouration, blemishes, arises, airholes etc. Only lined or coated plywood with very tight joints shall be used to achieve this finish. The panel size shall be uniform and as large as practicable. Any minor blemishes that might occur shall be made good by the Contractor.

4.20.5 Unformed Surfaces

Finishes to unformed surfaces of concrete shall be classified as U1, U2, and U3, 'spaded or bonded concrete'. Where the class of finish is not specified the concrete shall be finished to Class U1.

Class U1 finish is the first stage for Class U2 and U3 finishes and for a bonded concrete surface. Class U1 finish shall be a levelled and screeded, uniform plain or ridged finish which (unless it is being converted to Class U2, U3, or bonded concrete) shall not be disturbed in any way after the initial set and during the period of curing, surplus concrete being struck off immediately after compaction.

Where a bonded concrete surface is specified, the laitance shall be removed from the Class U1 finished surface and the aggregate exposed while the concrete is still green.
A spaded finish shall be a surface free from voids and brought to a reasonably uniform appearance by the use of shovels as it is placed in the Works.

Class U2 finish shall be a wood float finish. Floating shall be done after the initial set of the concrete has taken place and the surface has hardened sufficiently. The concrete shall be worked no more than is necessary to produce a uniform surface free from screed marks.

Class U3 finish shall be a hard smooth steel-trowelled finish. Trowelling shall not commence until the moisture film has disappeared and the concrete has hardened sufficiently to prevent excess laitance from being worked into the surface. The surfaces shall be trowelled under firm pressure and left free from trowel marks.

The addition of dry cement, mortar or water shall not be permitted during any of the above operations.

4.20.6 Integral Cement Finish on Concrete Floor

In all cases where integral cement finish on a concrete floor has been specified, the top layer of concrete shall be screeded off to proper level and tamped with tamper so that the aggregate shall be forced below the surface. The surface shall be finished with a wooden float and a trowel with pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on the surface. Where specified, a floor hardener as approved by the Engineer shall be supplied and used as recommended by the manufacturer.

4.21 Repair and Replacement of Unsatisfactory Concrete

Immediately after the shuttering is removed, all the defective areas such as honey-combed surfaces, rough patches, and holes left by form bolts etc. shall be inspected by the Engineer who may permit patching of the defective areas or reject the concrete work.

All through holes for shuttering shall be filled for full depth and neatly plugged flush with surface.

Rejected concrete shall be removed and replaced by the Contractor at no additional cost to the Employer.

For patching of defective areas all loose materials shall be removed, and the surface shall be prepared as approved by the Engineer.

Bonding between hardened and fresh concrete shall be done either by placing cement mortar with approved bonding agent or by applying epoxy. The decision of the Engineer as to the method of repairs to be adopted shall be final and binding on the Contractor. The surface shall be saturated with water for 24 hours before patching is done with 1:5 cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as approved by the Engineer.

All the form bolt repairs and delayed repairs shall be carried out using a proportion of white cement in repair mix to the approval of the Engineer, so as to match the colour of the surrounding area.

4.22 Vacuum Dewatering of Slabs

Where specified floor slabs, either grade or suspended, shall be finished by vacuum dewatering including all operations such as poker vibration, surface vibration, vacuum processing, floating and trowelling as per equipment manufacturers recommendation. The equipment to be used shall be subject to the Engineer's approval.

4.23 Hot Weather Requirements

Concreting during hot weather shall be carried out as per IS: 7861 (Part I).

Adequate provisions shall be made to lower concrete temperatures which shall not exceed 33^{o} C at the time of placement of fresh concrete.

Where directed by the Engineer, the Contractor shall spray non-wax based curing compound on unformed concrete surfaces at no extra costs.

4.24 Liquid Retaining Structures

The Contractor shall take special care for concrete for liquid retaining structures, underground structures and those others specifically called for to guarantee the finish and water tightness.

The minimum level of surface finish for liquid retaining structures shall be Type F2. All such structures shall be hydro-tested.

The Contractor shall make all arrangements for hydro-testing of structure, all arrangements for testing such as temporary bulk heads, pressure gauges, pumps, pipe lines etc.

Any temporary arrangements that may have to be made to ensure stability of the structures shall also be considered to have been taken into account while quoting the rates.

Any leakage that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement/epoxy pressure grouting, guniting or such other methods as may be approved by the Engineer. All such rectification shall be done by the Contractor to the entire satisfaction of the Employer/Engineer at no extra cost to the Employer.

4.25 Testing Concrete Structures for Leakage

Hydro-static test for water tightness shall be done at full storage level or soffit of cover slab, as may be directed by the Engineer, as described below:

In case of structures whose external faces are exposed, such as elevated tanks, the requirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and remain completely dry during the period of observation of seven days after allowing a seven day period for absorption after filling with water.

In the case of structures whose external faces are buried and are not accessible for inspection, such as underground tanks, the structures shall be filled with water and after the expiry of seven days after the filling; the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hrs. over a period of seven days. Backfilling shall be withheld till the tanks are tested. The total drop in surface level over a period for seven days shall be taken as an

indication of the water tightness of the structure. The Engineer shall decide on the actual permissible nature of this drop in the surface level, taking into account whether the structures are open or closed and the corresponding effect it has on evaporation losses. Unless specified otherwise, a structure whose top is covered shall be deemed to be water tight if the total drop in the surface level over a period of seven days does not exceed 40 mm.

Each compartment/segment of the structure shall be tested individually.
For structures such as pipes, tunnels etc. the hydrostatic test shall be carried out by filling with water, after curing as specified, and subjecting to the specified test pressure for specified period. If during this period the loss of water does not exceed the equivalent of the specified rate, the structure shall be considered to have successfully passed the test.

4.26 Optional Tests

If the Engineer is not satisfied with the results of the tests under Clause 4.5 or otherwise considers that the materials i.e. cement, sand, coarse aggregates, reinforcement and water are not in accordance with the Specifications or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, to be approved by the Engineer, as per relevant IS Codes. Contractor shall have to pay for these tests.

In the event of any work being suspected of faulty material or workmanship requiring its removal or if the works cubes do not give the stipulated strengths, the Engineer reserves the right to order the Contractor to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, etc. The Engineer also reserves the right to ask the Contractor to dismantle and re-do such unacceptable work, at no cost to the Employer.

If the structure is certified as failed by Engineer, the cost of the test and subsequent dismantling/reconstruction shall be borne by the Contractor.

The quoted unit rates/prices of concrete shall be deemed to provide for all tests mentioned above.

4.27 Acceptance Criteria

Any concrete work shall satisfy the requirements given below individually and collectively for it to be acceptable.

a) Properties of constituent materials;
b) Characteristic compressive strength;
c) Specified mix proportions;
d) Minimum cement content;
e) Maximum free-water/cement ratio;
f) Workability
g) Temperature of fresh concrete;
h) Density of fully compacted concrete;
i) Cover to embedded steel;
j) Curing;
k) Tolerances in dimensions;
l) Tolerances in levels;
m) Durability;
n) Surface finishes;
o) Special requirements such as;
    i) Water tightness
    ii) Resistance to aggressive chemicals
    iii) Resistance to freezing and thawing
    iv) Very high strength
    v) Improved fire resistance
    vi) Wear resistance

vii) Resistance to early thermal cracking

The Engineer's decision as to the acceptability or otherwise of any concrete work shall be final and binding on the Contractor.

For work not accepted, the Engineer may review and decide whether remedial measures are feasible so as to render the work acceptable. The Engineer shall in that case direct the Contractor to undertake and execute the remedial measures. These shall be expeditiously and effectively implemented by the Contractor. Nothing extra shall become payable to the Contractor by the Employer for executing the remedial measures.

4.28 Mode of Measurement and Payment

The unit rate for concrete work under various categories shall be all inclusive and no claims for extra payment on account of such items as leaving holes, embedding inserts, etc. shall be entertained unless separately provided for in the Schedule of Quantities. No extra claim shall also be entertained due to change in the number, position and/or dimensions of holes, slots or openings, sleeves, inserts or on account of any increased lift, lead of scaffolding etc. All these factors should be taken into consideration while quoting the unit rates. Unless provided for in the Schedule of Quantities the rates shall also include fixing inserts in all concrete work, whenever required.

Payments for concrete will be made on the basis of unit rates quoted for the respective items in the Schedule of Quantities. No deduction in the concrete quantity will be made for reinforcements, inserts etc. and opening less than 0.100 of a sq.m. and 0.010 cu.m where concrete is measured in cu.metres. Where no such deduction for concrete is made, payment for shuttering work provided for such holes, pockets, etc. will not be made. Similarly the unit rates for concrete work shall be inclusive or exclusive of shuttering as provided for in the Schedule of Quantities.

Payment for beams will be made for the quantity based on the depth being reckoned from the underside of the slabs and length measured as the clear distance between supports. Payment for columns shall be made for the quantity based on height reckoned upto the underside of slabs/beams.

The unit rate for precast concrete members shall include formwork, mouldings, finishing, hoisting and setting in position including setting mortar, provision of lifting arrangement etc. complete. Reinforcement and inserts shall be measured and paid for separately under respective item rates.

Only the actual quantity of steel embedded in concrete including laps as shown on drawings or as approved by Engineer shall be measured and paid for, irrespective of the level or height at which the work is done. The unit rate for reinforcement shall include all wastages, binding wires, chairs, spacer bars etc. For which no separate payment shall be made.

Where the formwork is paid for separately, it shall be very clearly understood the payment for formwork is inclusive of formwork, shuttering, shoring, propping scaffolding etc. Only the net area of concrete formed (shuttered) shall be measured for payment.

4.29 Waterstops

4.29.1 Material

The material for the PVC waterstops shall be a plastic compound with the basic resin of polyvinyl chloride and additional resins, plasticizers, inhibitors, which satisfies the performance characteristics specified below as per IS:12200. Testing shall be in accordance with IS: 8543.

a) Tensile strength : 11.6 N/mm^2 minimum
b) Ultimate elongation : 300% minimum
c) Tear resistance : 4.9 N/mm^2 minimum

d)	Stiffness in flexure	:	2.46 N/mm^2 minimum
e)	Accelerated extraction		
	i) Tensile strength	:	10.50 N/mm^2 minimum
	ii) Ultimate elongation	:	250% minimum
(f)	Effect of Alkali	:	7 days
	i) Weight increase	:	0.10% maximum
	ii Weight decrease	:	0.10% maximum
	iii) Hardness change	:	± 5 points
(g)	Effect of Alkali	:	28 days
	i) Weight increase	:	0.40% maximum
	ii) Weight decrease	:	0.30% maximum
	iii) Dimension change	:	±1%

PVC water stops shall be either of the bar type, serrated with centre bulb and end grips for use within the concrete elements or of the surface (kicker) type for external use.

Flexible water stops shall be fully supported in the formwork, free of nails and clear of reinforcement and other fixtures. Damaged water stops shall be replaced and during concreting care shall be taken to place the concrete so that water stops do not bend or distort.

PVC water stops shall be of approved manufacture. Samples and the test certificate shall be got approved by the Engineer before procurement for incorporation in the works.

4.29.2 Workmanship

Waterstops shall be cleaned before placing them in position Oil or grease shall be removed thoroughly using water and suitable detergents.

Waterstops shall be procured in long lengths as manufactured to avoid joints as far as possible. Standard L or T type of intersection pieces shall be procured for use depending on their requirement. Any non-standard junctions shall be made by cutting the pieces to profile for jointing. Lapping of waterstops shall not be permitted. All jointing shall be of fusion welded type as per manufacturer's instructions.

Waterstops shall be placed at the correct location/level and suitably supported at intervals with the reinforcement to ensure that it does not deviate from its intended position during concreting and vibrating. Particular care shall also be taken to ensure that no honey-combing occurs because of the serrations/end grips. Projecting portions of the waterstops embedded in concrete shall be thoroughly cleaned of all mortar/ concrete coating before resuming further concreting operations. The projecting waterstop shall also be suitably supported at intervals with the reinforcement to maintain its intended position during concreting so as to ensure that it does not bend leading to formation of pockets.

4.29.3 Measurement

Measurement shall be in running metres correct to two places of decimal. No separate payment shall be made for joints or intersection pieces.

4.30 Curing, Protecting, Repairing and Finishing

4.30.1 Curing

All concrete shall be cured by keeping it continuously damp for the period of time required for complete hydration and hardening to take place. Preference shall be given to the use of continuous sprays, or ponded water, continuously saturated coverings of sacking, canvas, hessain or other absorbent materials, or approved effective curing compounds applied with spraying equipment capable of producing a smooth, even textured coat. Extra precautions shall be exercised in curing

concrete during cold and hot weather as outlined hereinafter. The quality of curing water shall be the same as that used for mixing concrete.

4.30.1.1 Curing with Water

Fresh concrete shall be kept continuously wet for a minimum period of 10 days from the date of placing of concrete, following a lapse of 12 to 14 hours after laying of concrete. The curing of horizontal surfaces exposed to the drying winds shall however begin as soon as the concrete has hardened. Water shall be applied to formed surfaces immediately upon removal of forms. Quantity of water applied shall be controlled so as to prevent erosion of freshly placed concrete.

4.30.1.2 Continuous Spraying

Curing shall be assured by use of an ample water supply under pressure in pipes, with all necessary appliances of hose, sprinklers and spraying devices. Continuous fine mist spraying or sprinkling shall be used, unless otherwise specified or approved by the Engineer.

4.30.1.3 Alternate Curing Methods

Whenever in the judgment of the Engineer, it is necessary to omit the continuous spray method, a covering of clean sand or other approved means such as wet gunny bags, which will prevent loss of moisture from the concrete, may be used. No type of covering will be approved which would stain or damage the concrete during or after the curing period. Covering shall be kept continuously wet during curing period. For curing of concrete in sidewalks, floors, flat roofs of other level surfaces, the ponding method of curing is preferred. The method of containing the ponded water shall be approved by the Engineer. Special attention shall be given to edges and corners of the slabs to ensure proper protection to these areas. The ponded areas shall be kept continuously filled with water during the curing period.

4.30.1.4 Curing Compound

Surface coating type-curing compounds shall be used only by special permission of Engineer. Curing compounds shall be liquid type white pigmented, confirming to US Bureau of Reclamation specification. No curing compound shall be used on surfaces where future blending with concrete, water of acid proof membrane or painting is specified.

4.30.1.5 Curing Equipment

All equipment and materials required for curing shall be on hand and ready for use before concrete is placed.

4.30.2 `Protecting Fresh Concrete

Fresh concrete shall be protected from defacements and damage due to construction operations by leaving forms in place for an ample period. Newly placed concrete shall be protected by approved means such as tarpaulins from rain, sun and winds. Steps as approved by the Engineers hall also be taken to protect immature concrete from damage by debris, excessive lading, vibration, abrasion or contact with other materials, etc. that may impair the strength and/or durability of the concrete. Workmen shall be warned against and prevented from disturbing green concrete during its setting period. If it is necessary that the workmen enter the area of freshly placed concrete, the Engineer may require that bridges be placed over the area.

4.30.3 Repair and Replacement of Unsatisfactory Concrete

4.30.3.1 General

Immediately after the shuttering is removed, the surface of concrete shall be very carefully inspected and all defective areas attended to by the Engineer may permit patching of the defective areas or reject the concrete unit either partially or entirely. Rejected concrete shall be removed and replaced by the contractor. Holes shall be filled with mortar composed of one part of cement to one and half parts of sand passing 2.36 mm IS sieve after removing any loose stones adhering to the concrete. Concrete surfaces shall be finished as described in specifications or as directed by the Engineer. Superficial honey combed surfaces and rough patches shall be similarly made good immediately after removal of shuttering, in the presence of the Engineer and superficial water and air holes shall be filled in. The mortar shall be well worked into the surface with a wooden float. Excess water shall be avoided. Unless instructed otherwise by the Engineer, the surface of the exposed concrete placed against shuttering shall be rubbed down immediately on removal of shuttering to remove fine or other irregularities, care being taken to avoid damaging the surface. Surface irregularities shall be removed by grinding. If reinforcement is exposed or the honeycombing occurs at vulnerable positions e.g. ends of beams or columns, it may be necessary to cut out the member completely or in part and reconstruct. The decision of the Engineer shall be final in this regard. If only patching is necessary, the edges being cut perpendicular to the affected surface or with a small undercut if possible. Anchors, tees or dovetail slots shall be provided whenever necessary to attach the new concrete securely in place. An area extending several centimeters beyond the edges and the surfaces of the prepared voids shall be saturated with water for 24 hours immediately before the patching material is placed.

4.30.3.2 Use of Epoxy

The use of epoxy for bonding fresh concrete used for repairs will be permitted upon written approval of the Engineer. Epoxies shall be applied in strict accordance with the instructions of the manufacturer.

4.30.3.3 Method of Repair

Small size holes having surface dimensions about equal to the depth of the hole, holes left after removal of form bolts, grout insert holes and slots cut for repair of cracks shall be repaired as follows.

The hole to be patched shall be roughened and thoroughly soaked with clean water until absorption stops. A 5 mm thick layer of grout of equal parts of cement and sand shall be well brushed into the surface to be patched, followed immediately by the patching concrete which shall be well consolidated with a wooden float and left slightly protrude of the surrounding surface. The concrete patch shall be built up in 10 mm thick layers, after an hour or more, depending upon weather conditions, it shall be worked off flush with a wooden float and a smooth finish obtained by wiping with hessian. A steel trowel shall be used for this purpose. The mix for patching shall be of the same materials and in the same proportion as that used in the concrete being repaired, although some reduction in the maximum size of the coarse aggregates may be necessary and the mix shall be kept as dry as possible. Mortar filling by air pressure (gunniting) shall be used for repair of areas too large and/or too shallow for patching with mortar. Patched surfaces shall be given a final treatment to match the colour and texture of the surrounding concrete. White cement shall be substituted for ordinary cement, if so directed by the Engineer, to match the shade of the patch with the original concrete.

4.30.4 Curing of Patched Work

The patched area shall be covered immediately with an approved non-staining, water-saturated material such as gunny bags which shall be kept continuously wet and protected against sun and

wind for a period of 24 hours. Thereafter, the patched area shall be kept wet continuously by a fine spray or sprinkling for not less than 10 days. All fillings shall be tightly bounded to the concrete and shall be sound, free from shrinkage cracks after the fillings have been cured and dried.

4.31 Approval by the Engineer

All materials, procedures and operations used in the repair work shall be subject to the approval of the Engineer.

4.32 Precast Concrete

4.32.1 General

Precast concrete units, whether manufactured on or off site, shall comply in every way with the provisions of the contract for in situ concrete. Wherever possible, precast units shall be hydraulically pressed. When ready for incorporation in the works, precast units shall be responsible for the accuracy of the level, shape of the bed or platform. A suitable serial number and the date of casting shall be impressed or painted on each unit.

4.32.2 Striking Forms

Side shutters shall not be struck in less than 24 hours after depositing concrete and no precast unit shall be lifted until the concrete reaches strength of at least twice the stress to which the concrete may be subjected to at the time of lifting.

4.32.3 Precast Units

The lifting and removal of precast units shall be undertaken without causing shock, vibration or undue bending stresses to or in the units. Before lifting and removal takes place, contractor shall satisfy the Engineer or his representative that the methods he proposes to adopt for these operations will not over-stress or otherwise effect seriously the strength of the precast units. The reinforced side of the units shall be distinctly marked.

4.32.4 Curing

All precast work shall be protected from the direct rays of the sun for at least 7 days after casting and during that period each unit shall be kept constantly watered or preferably be completely immersed in water if the size of the unit so permits.

4.33 Slots, Openings, etc.

4.33.1 General

Slots, openings or holes, pockets, etc., shall be provided in the concrete work in the approved positions or as directed by Engineer. Short pipes with puddle collar shall be fixed in the sidewall of suction pipes. They shall be supplied at the appropriate time during construction. Any deviation from the approved drawings shall be made good by contractor at own expense, without damaging any other work. Sleeves, bolts, inserts etc., shall also be provided in concrete work where so required.

4.34 Grouting

4.34.1 Standard Grout

Grout shall be provided as specified on the drawings. The proportion of Standard Grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. Surfaces to be grouted shall be thoroughly roughened and cleaned. All Structural steel elements to be grouted shall be cleaned of oil, grease, dirt etc. The use of hot, strong caustic solution for this purpose will be permitted. Prior to grouting, the hardened concrete shall be saturated with water and just before grouting water in all pockets shall be removed. Grouting once started shall be done quickly and

continuously. Variation in grout mixes and procedures shall be permitted if approved by Engineer. The grout proportions shall be limited as follows:

Use	Grout Thickness	Mix Proportions	W/C Ratio (max)
a) Fluid mix	Under 25mm	One part Portland Cement to one part sand	0.4
b) General mix	25mm and over but less than 50mm	One part Portland Cement to 2 parts of sand	0.53
c) Stiff mix	50mm and over	One part Portland Cement to 3 parts of sand	0.53

4.34.2 Non-Shrinking Grout for Equipment Foundation

Non-shrinking grout shall be used for grouting of machine base plates, anchor bolts, other anchoring devices and at locations where ordinary grouts are ineffective due to shrinkage. It shall be composed of a type of expansive hydraulic sheeting binder and select-graded aggregates. It shall have properties as per "*Table 11: Proportions for Non-Shrinking Grout*".

Table 11: Proportions for Non-Shrinking Grout

S. No.	Properties	Values
1	Maximum grain size	6 mm
2	Water % (for 80% flow)	15.17
3	Density of hardened grout	2.27 – 2.30 gm/m
4	Compressive strength N/sqmm	
	Minimum 3 days	23
	7 days	34

Mixing, batching, cleaning, preparation of surface and curing of non-shrinking grout shall be done as per manufacturer's instructions.

4.35 Inspection

a. All materials, workmanship and finished construction shall be subject to continuous inspection and approval of the Engineer.
b. All materials supplied by the Contractor and all work or construction performed by the Contractor which is rejected as not being in conformity with the specifications and requirements, shall be immediately replaced.
c. All concrete shall be protected against damage until final acceptance by the Engineer.

4.36 Clean-up

a. Upon completion of the concrete work, all forms, equipment, construction tools, protective coverings and any debris resulting from the work shall be removed from the premises.
b. All debris i.e. empty containers, scrap wood, etc., shall be removed to "dump" daily, or as directed by the Engineer.
c. The finished concrete surfaces shall be left in a clean condition satisfactory to the Engineer.

4.37 Preformed Fillers and Joint Sealing Compound

4.37.1 Materials

Preformed filler for expansion/isolation joints shall be non-extruding and resilient type of bitumen impregnated fibres conforming to IS: 1838 (Part I).
Bitumen coat to concrete/masonry surfaces for fixing the preformed bitumen filler strip shall conform to IS: 702. Bitumen primer shall conform to IS: 3384.

Sealants shall be of the following types:

4.37.1.1 Sealant Type A

Sealant Type A shall be a gun grade, non-slumping compound suitable for sealing horizontal, vertical and soffit joints in water retaining structures. It shall be a UK WFBS material approved for unrestricted use in contact with potable water to the full exposure condition of 15000 mm^2/l, and shall not support bacterial growth.
It shall be stable and shall have a low water absorption and good adhesion to concrete.
Hardness (Shore A) : > 12
Transverse Movement Accommodation : ±15%

4.37.1.2 Sealant Type B

Sealant type shall be a gun grade compound, suitable for sealing vertical movement and construction joints in concrete structures. It shall be flexible, resistant to aging, physical damage and weathering and shall have good adhesion to concrete.
Hardness (Shore A) : > 12
Transverse Movement Accommodation : ±12.5%

4.37.1.3 Sealant Type C

Sealant type C shall be similar to Type B above. In addition it shall have been designed for sealing movement and construction joints in hydraulic and water retaining structures and shall be suitable for use in contact with potable water.
Hardness (Shore A) : > 20
Transverse Movement Accommodation : ±12.5%

4.37.1.4 Sealant Type D

Sealant Type D shall be a pourable compound suitable for sealing horizontal movement and construction joints in concrete structures. It shall be flexible, resistant to aging, physical damage and weathering and shall have good adhesion to concrete.
Hardness (Shore A) : > 9
Transverse Movement Accommodation : ±12.5%

4.37.1.5 Sealant Type E

Sealant Type E shall be a cold pouring compound complying with BS 5212, suitable for sealing movement and construction joints in concrete paved areas. It shall be resistant to fuels, oils and hydraulic fluids. It shall be tough, abrasion-resistant and shall not decompose in strong sunlight.
Hardness (Shore A) : > 12
Transverse Movement Accommodation : ±12.5%

4.37.1.6 Approved Sealants

The following approved sealants meet the above specifications.
Sealant Type A, B and C : Thioflex 600 gun grade

Sealant Type	:	Thioflex 600 pourable grade
Sealant Type E	:	Colpor 200

The hardness value specified in the above summaries is the Shore A Durometer value at 14 days at 25^{o} C and 50% RH. The specified transverse movement values are based on joints having a width to depth ratio of 1.5: 1.

The Contractor may use the above sealants or ones meeting equivalent or higher specifications.

4.37.2 Workmanship

The thickness of the preformed bitumen filler shall be 25mm for expansion joints and 50mm for isolation joints around foundation supporting rotatory equipments. Contractor shall procure the strips of the desired thickness and width in lengths as manufactured. Assembly of small pieces/thicknesses of strips to make up the specified size shall not be permitted.

The concrete/masonry surface shall be cleaned free from dust and any loose particles. When the surface is dry, one coat of industrial blown type bitumen of grade 85/25 conforming to IS:702 shall be applied hot by brushing at the rate of 1.20 kg/sq.m. When the bitumen is still hot the preformed bitumen filler shall be pressed and held in position till it completely adheres. The surface of the filler against which further concreting/masonry work is to be done shall similarly be applied with one coat of hot bitumen at the rate of 1.20 kg/sq.m.

Sealing compound shall be heated to a pouring consistency for enabling it to run molten in a uniform manner into the joint. Before pouring the sealing compound, the vertical faces of the concrete joint shall be applied hot with a coat of bitumen primer conforming to IS:3384 in order to improve the adhesive quality of the sealing compound.

Expansion joints between beams/slabs shall be provided with 100mm wide x 4mm thick mild steel plate at the soffit of RCC beams/slabs to support and prevent the preformed joint filler from dislodging. This plate shall be welded to an edge angle of ISA 50 x 50 x 6mm provided at the bottom corner, adjacent to the expansion joint of one of the beams/slabs, by intermittent fillet welding. Steel surfaces shall be provided with 2 coats of red oxide zinc chrome primer and 3 coats of synthetic enamel paint finish.

The Contractor shall construct recesses at all joints and on both faces of the concrete work except on the underside of ground slabs. The recesses shall be accurately formed to the lines and dimensions shown on the Drawings or as agreed with the Engineer.

The Contractor shall prepare the surfaces of the recess and shall supply a joint sealer and fill or caulk the recess completely with it.

Joint sealing shall not be commenced without the approval of the Engineer. In reservoir joints the sealer shall be poured after completion of the water tightness test, to the satisfaction of the Engineer.

All joint sealers shall be from an approved manufacturer. The Contractor shall supply the manufacturer's test certificates for each consignment of each type of joint sealant delivered to the Site and shall if requested supply to the Engineer sufficient samples of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate test procedure.

Sealants shall be installed in strict accordance with the manufacturer's instructions. De-bonding strip shall be used in conjunction with the sealers as indicated on the Drawings. The de-bonding strip shall be compatible with the joint sealer and shall be resistant to attach from the primer used to bond the sealer to the concrete.

Polysulphide and polyurethane sealants shall not abut bitumen sealers. Surfaces to receive Polysulphide and polyurethane sealants shall be kept free from bituminous paints. All sealants shall be appropriate for the prevailing climatic conditions. Bituminous sealants shall comply with the BS 2499 for Type A1. Polysulphide sealants shall comply with IS 12118.

4.37.3 Measurement

Measurement for the preformed joint filler shall be in sq.m correct to two places of decimal for the specified thickness as per items of work. Measurement for applying the bitumen coat to concrete/masonry surfaces shall be in sq.m correct to two places of decimal. Measurement for the joint sealing compound shall be in running metres correct to two places of decimal for the specified width and thickness as per the items of work. Measurement for the mild steel corner angle and plate shall be by weight as per the items of work.

4.38 Concreting Records

A written record of the concrete works shall be made each day by the Contractor and kept available for inspection by the Engineer. The diary shall contain notes and records of:

(a) The names of the Contractor's Engineer who are responsible for the different phases of the concrete work and also the names of their assistants.

(b) The temperatures of air, water, cement, aggregate, together with the air humidity and type of weather.

(c) Deliveries to the Site of concrete materials (quantity, brand of concrete, etc).

(d) Inspections carried out, tests performed, etc. and their results.

(e) Times of commencement and completion of different parts of the concrete works and times of erection and striking of forms.

(f) Quantity of cement, fine and coarse aggregate and admixture used for each section of work and the number and kind of test samples taken on these ingredients and water.

CONCRETE POUR CARD

CLIENT : DATE : POUR NO. :

PROJECT : STRUCTURE :

Contractor : MAX. AGGREGATE SIZE/ SLUMP :

START / COMPLETION TIME : /

DRG. NO. :

MIXING TIME :

CONCRETE GRADE / QUANTITY : /

SL. NO.	ITEM			Contractor's Rep. Sign	Engineer's Sign	Remarks
1.	BEFORE CONCRETING	CENTRELINES CHECKED				POUR AUTHORISED SITE ENGINEER
2.		FORMWORK AND STAGING CHECKED FOR ACCURACY, STRENGTH & FINISH				
3.		REINFORCEMENT CHECKED				
4.		COVER TO REINFORCEMENT CHECKED				
5.		VERIFIED TEST CERTIFICATE FOR CEMENT/STEEL		YES / NO	YES / NO	
6.		ADEQUACY OF MATERIALS / EQUIPMENT FOR POUR		YES / NO	YES / NO	
7.		EMBEDDED PART S	CIVIL			

		CHECKED	MECHANICAL			
		(LOCATION & PLUMB)	ELECTRICAL			
8.	SOFFIT(S) & POUR TOP(T) LEVELS CHECKED BEFORE (B) & AFTER (A) FORM REMOVAL (ONLY OF BEAMS OF OVER 10 M SPAN & IMPORTANT STRUCTURE LIKE T.G. ETC.)	S(B) T(B) S(A) T(A)				
9.	CONSTRUCTION JOINTS LOCATION & TIME (IF NOT AS PER DRAWING)					
10.	CEMENT CONSUMPTION IN KGS.					
11.	NUMBER OF CUBES AND IDENTIFICATION MARKS					
12.	TEST CUBE RESULTS (7 DAYS / 28 DAYS)					
13.	CONCRETE CONDITION ON FORM REMOVAL	V.GOOD/GOOD/FAIR/POOR				

SITE-IN-CHARGE

NOTES : 1. EACH ITEM TO BE CHECKED AND SIGNED BY THE RESPECTIVE ENGINEERS.

2. ITEMS 8 TO 13 (BOTH INCLUSIVE) TO BE FILLED ONLY BY ENGINEER.

3. EACH POUR TO HAVE SEPARATE CARDS, IN TRIPLICATE ONE EACH FOR CLIENT, CONSULTANT & SITE OFFICE.

UNDER REMARKS INDICATE DEVIATIONS FROM DWGS. & SPECIFICATIONS, CONGESTION IN REINFORCEMENT IF ANY, UNUSUAL OCCURENCES, SUCH AS FAILURE OF EQUIPMENTS, SINKING OF SUPPORTS / PROPS. HEAVY RAINS AFFECTING CONCRETING, POOR COMPACTION, IMPROPER CURING, OTHER DEFICIENCIES, OBSERVATIONS ETC.

End of Chapter-4

CHAPTER 5

ROADS AND DRAINS

CHAPTER 5

ROADS AND DRAINS

5.1 Definitions

The words like Contract, Contractor, Engineer (synonymous with Engineer-in-charge), Drawings, Employer, Government, Works and Work Site used in these Specifications shall be considered to have the meaning as understood from the definitions of these terms given in the General Conditions of Contract.

The following abbreviations shall have the meaning as set forth below:

MORTH	:	Ministry of Road Transport and Highways
IRC	:	Indian Roads Congress
IS	:	Indian Standard published by the Bureau of Indian Standards
GSB	:	Granular Sub Base
WMM	:	Wet Mix Macadam
BM	:	Bituminous Macadam
BC	:	Bituminous Concrete
CBR	:	California Bearing Ratio
AASHTO	:	American Association of State Highway and Transportation Officials
ASTM	:	American Society for Testing and Materials
BS	:	British Standard published by the British Standards Institution

The various elements in the cross-section of a road (STP) referred to in these Specifications are shown in the cross-sections in **Fig. 5-1**.

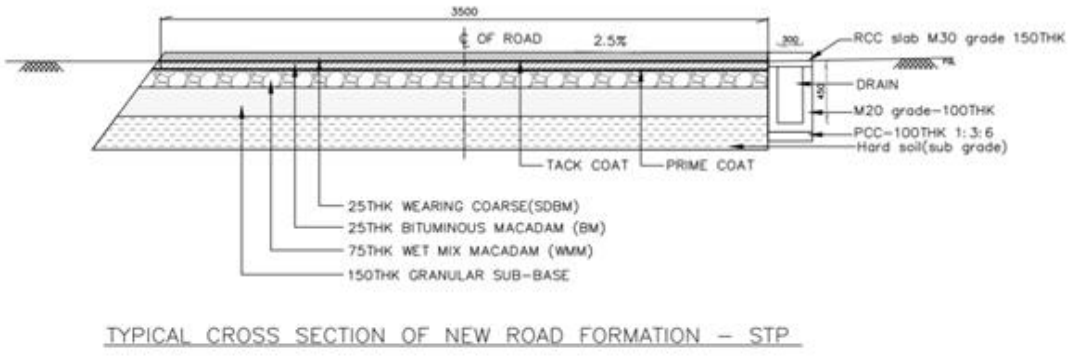

Fig. 5-1: Proposed Typical Cross Section of the Road (STP)

5.2 Applicable Codes and Specifications

The following specifications, standards and codes are referred to in this part.

IS : 460 (Parts 1 to 3) : Specification for Test sieves
IS : 1077 : Common burnt clay building bricks - Specification
IS : 1124 : Method of test for determination of water absorption, apparent specific gravity and porosity of natural building Aggregates / stones
IS : 1195 : Specification for Bitumen Mastic for Flooring
IS : 1196 : Code of Practice for Laying Bitumen Mastic Flooring
IS : 1834 : Specification for Hot Applied Sealing Compounds for Joints in Concrete
IS : 2386 (Parts 1 to 8) : Methods of test for aggregates for concrete
IS : 2720 (Part 5) : Method of Test for Soils for determination of Liquid and plastic limit.
IS : 6241 : Method of test for determination of stripping value of road aggregates.
IRC : 16 : Specification for priming of Base Course with Bituminous Primers.
IRC : 17 : Tentative specification for Single Coat Bituminous Surface Dressing
IRC : 19 : Standard specifications and code of practice for water bound macadam
IRC : 29 : Specification for bituminous concrete (Asphaltic Concrete) for road pavement.
MORTH Specifications : Ministry of Road Transport and Highways Specifications for Road and Bridge works
SECTION-100: GENERAL
SECTION-300 : EARTHWORK
SECTION-401 : GRANULAR SUB BASE
SECTION-406 : WET MIX MACADAM
SECTION-504 : BITUMINOUS MACADAM
SECTION-507 : BITUMINOUS CONCRETE

5.3 Road Configuration

The roads shall be installed in layers as per Drawing over the back fill as per concerned sections of MORTH. In Plant premise all the motorable road width is minimum 3.5m.
On laying of Pumping main/sewer lines in the trenches, the roads shall be restored to its original condition in layers as per Drawing over the back fill as per concerned sections of MORTH

Technical specification:

a) Backfill over the water lines / sewer lines to the desired level as per drawing and specification.
b) Approved soil compacted in layers as per drawing, using soil deposited at site from road cutting and excavation to achieve compaction level Table 300-2 and Section 301 of MORTH Technical specification.
c) Layer of sand / stone dust as per drawing to achieve 97% relative compaction of laboratory dry density to meet requirement of table 300-2 of MORTH specification.
d) Granular Sub base as per section 401 of MORTH specification.

e) Wet mix macadam (WMM) as per section 406 of MORTH specification.
f) Bituminous macadam (BM) as per section 504 of MORTH specification.
g) Bituminous concrete (BC) as per section 507 of MORTH specification.

5.4 Materials

5.4.1 General

All materials shall be obtained from local sources and shall conform to technical specifications and be subject to Engineer's approval prior to use.

5.4.2 Approved soil for Subgrade / Embankment

The materials used in embankments, subgrades and miscellaneous backfills shall be soil, moorum, gravel, a mixture of these or any other material approved by the Engineer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment/ subgrade.

The Contractor shall carry out the excavation in such a manner that the acceptable materials are excavated separately for use in backfill/restoration works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

It shall be ensured that the subgrade material when compacted to the density requirements as in Table 5.1 (As per Table 300-2 of MORTH specification) shall yield the design CBR value of the subgrade.

Table 5.1: Compaction requirement for Subgrade
(As per Table 300-2 of MORTH Specification)

Type of work/material		**Relative compaction as % of max. lab dry density as per IS: 2720 (Part 8)**
1	Subgrade and earthen shoulders	Not less than 97
2	Embankment	Not less than 95

The Contractor shall at least 7 working days before commencement of compaction submit the following to the Engineer for approval:

i) The values of Maximum Dry Density and Optimum Moisture Content obtained in accordance with IS: 2720 (Part 7) or (Part 8), as the case may be, appropriate for each of the fill materials he intends to use.
ii) A graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum moisture content were determined.
iii) The Dry density-moisture content - CBR relationships for light, intermediate and heavy compactive efforts (light corresponding to IS: 2720 (Part 7), heavy corresponding to IS: 2720 (Part 8) and intermediate in-between the two) for each of the fill materials he intends to use in the subgrade.

Once the above information has been approved by the Engineer, it shall form the basis for compaction.

5.4.3 Granular Sub Base

The material to be used for the work shall be natural sand, murum, gravel, crushed stone, or combination thereof depending upon the grading required. Materials like crushed slag, crushed concrete, brick metal and kankar may be allowed only with the specific approval of the Engineer. The material shall be free from organic or other deleterious constituents and conform to grading-iii given in **Table 5.2: Gradation for coarse graded granular Sub base.** (As per Table 400-1 of MORTH Specifications).

The CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions, which shall be taken as being the density relating to a uniform air, voids content of 5 per cent.

Table 5.2: Gradation for coarse graded granular Sub base.
(As per TABLE 400–1 of MORTH Specification)

IS Sieve	Percent by weight passing the IS Sieve		
Designation	**Grading I**	**Grading II**	**Grading III**
75.0 mm	100	-	-
53.0 mm	80-100	100	100
26.5 mm	55 - 90	70-100	55-75
9.50 mm	35-65	50-80	-
4.75 mm	25-55	40-65	10-30
2.36 mm	20-40	30-50	-
0.425 mm	10-15	10-15	-
0.075 mm	<5	<5	<5
CBR Value (Minimum)	30	25	20

Note: The material passing 425 micron (0.425 mm) sieve for all three gradings when tested according to IS : 2720 (Part 5) shall have a liquid limit and plasticity index not more than 25 and 6 per cent, respectively.

5.4.4 Coarse Aggregates

Coarse aggregate, stone chippings shall consist of natural or crushed stone, clean, hard, tough, durable and free from excess of flat, elongated, soft and disintegrated particles, dirt, salt, alkali, vegetable matter, adherent coatings, organic and other objectionable matter, and shall conform to the physical requirements given in **Table 5.3** and **Table 5.4** hereunder, as applicable. Aggregate for bituminous wearing courses shall, in addition, have good hydrophobic properties, i.e., the ability to retain the film of bituminous material applied to the stone in all weather conditions, especially in wet conditions. Basalt and dolerite are good in this respect; granite and quartzite are comparatively poor.

Table–5.3: Physical	**Test**	**Requirements**	**Test Method**

Requirements of Coarse Aggregate for Wet Mix Macadam (WMM) Sl. No			
1.	Los Angeles Abrasion Value*	40 percent (max.)	IS:2386 (Part – IV)
	Or		
	Aggregate Impact Value*	30 percent (max.)	IS:2386 (Part – IV) Or IS:5640***
2.	Flakiness Index **	15 percent (max.)	IS:2386 (Part I)
3.	Combined Flakiness and Elongation Indices**	35 percent (max.)	IS:2386 (Part I)

(*) Aggregate may satisfy requirements of either of two tests.

(**) Requirements of flakiness index shall be enforced only in case of crushed broken stone.

(***) Aggregates like brick, metal, kankar, laterite etc., which get softened in presence of water shall be tested for impact value under wet conditions in accordance with IS: 5640.

Table – 5.4: Physical Requirements of Coarse Aggregates for Dense Bituminous macadam (BM) (As per Table 500-8 of MORTH Specification)

Sl.No.	**Test**	**Requirements**	**Test Method**
1.	Los Angeles Abrasion Value*	35 percent (max.)	IS:2386 (Part – IV)
	Or		
	Aggregate Impact Value*	27 percent (max.)	IS:2386 (Part –
2.	Combined Flakiness and Elongation Indices (Total) **	35 percent (max.)	IS:2386 (Part I)
3.	Coating and Stripping of Bitumen Aggregate Mix	Min. Retained coating 95%	IS:6241
4.	Water Absorption	2 percent (max.)	IS:2386 (Part-III)
5.	Soundness		
	Loss with Sodium Sulphate – 5 cycles	12 percent (max.)	IS:2386 (Part-V)
	Loss with Magnesium Sulphate – 5 cycles	18 percent (max.)	

(*) Aggregate may satisfy requirements of either of two tests

(**) Requirement of flakiness index shall be enforced only in case of crushed broken stone

5.4.5 Murum/Kankar/Gravel

Murum shall contain a low-plasticity binder material mixed with hard granular particles, such as sand and/or gravel. Murum shall be of sound and hard quality, unaffected by weather, and shall be screened at the quarry, free from all impurities. Large lumps shall all be broken at the quarry, and murum delivered at the site must pass through a 63 mm ring. Murum shall not contain more than 5% to 8% of fines passing a 75-micron sieve.

Gravel shall be composed of large, coarse, silicious grains, sharp and gritty to the touch, thoroughly free from dirt, organic and deleterious matter. It shall be hard, tough, dense, and shall not contain particles larger than 12 mm, nor more than 10 percent silt.

5.4.6 Sand / Stone Dust

The sand / Stone dust shall consist of clean, hard, strong and durable pieces of crushed stone, crushed gravel, or a suitable combination of natural sand, crushed stone or gravel. They shall not contain dust, lumps, soft or flaky, materials, mica or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the embedded steel. Motorized sand washing machines should be used to remove impurities from sand. Fine aggregate having a positive alkali-silica reaction shall not be used. All fine aggregates shall conform to IS: 383, and tests for conformity shall be carried out as per IS: 2386 (Parts I to VIII). The Contractor shall submit to the Engineer the entire information indicated in Appendix A of IS: 383. The fineness modulus of fine aggregate shall neither be less than 2.0 nor greater than 3.5. The Sand used shall be coarse, sharp, gritty, clean, granular material. Only material passing through a 4.75 mm sieve and retained on a 75-micron sieve shall be used.

The sand / Stone dust / fine aggregates shall conform to the grading requirement in Table 5.5

Table 5.5: Gradation requirement of Sand / Fine aggregates
(As per Table 1000-2 of MORTH Specifications)

IS Sieve Size	Per cent by Weight Passing the Sieve		
	Zone I	Zone II	Zone III
10 mm	100	100	100
4.75 mm	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100
1.18 mm	30-70	55-90	75-100
600 micron	15-34	35-59	60-79
300 micron	5-20	8-30	12-40
150 micron	0-10	0-10	0-10

Note: When the grading falls outside the limits of any particular grading zone of sieves, other than the 600-micron IS Sieve, by a total amount not exceeding 5 percent, it shall be regarded as falling within that grading zone. However, for crushed stone sand, the permissible limit on the 150-micron IS Sieve is increased to 20 percent. Reference shall be made to clause: 4.3 of IS: 383.

5.4.7 Bituminous Materials

Bituminous materials shall conform to IS: 73, IS: 215, IS: 217 or IS: 454 as applicable and be of the grade specified.

Table 5.6: Physical requirements of Coarse aggregates for Bituminous concrete (BC). (As per TABLE 500-16: MORTH specifications)

PROPERTY	TEST	SPECIFICATION	METHOD OF TEST
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve.	IS: 2386 Part I
Particle shape	Flakiness and Elongation Index	Max 30% (Combined) 2	IS: 2386 Part I
Strength	Los Angles Abrasion Value or Aggregate Impact Value	Max 30% Max 24%	IS: 2386 Part IV
Polishing	Polished Stone Value	Min 55	BS: 812-114
Durability	Soundness: Sodium Sulphate or Magnesium Sulphate	Max 12% Max 18%	IS: 2386 Part V
Water Absorption	Water absorption	Max 2%	IS: 2386 Part III
Stripping	Coating and Stripping of Bitumen Aggregate Mixtures	Minimum retained coating 95%.	IS: 6241
Water Sensitivity	Retained Tensile Strength*	Min 80%	AASHTO 283

* If the minimum retained Tensile strength test falls below 80%, use of anti-stripping agent is recommended to meet the requirement.

5.5 Earth work

5.5.1 Earthwork in Excavation

In general, the excavation shall be in accordance to Specifications specified elsewhere.

Profiles of road excavation shall be laid at 50 m intervals or as specified in the Drawings to conform to the required alignment, sections, grades, and side slopes, and the lines of cuts shall be clearly marked.

Contractor shall on no account excavate beyond the slopes or below the specified grade unless so approved by the Engineer in writing. If excavation is done below the specified level or outside the section the Contractor shall be required to fill up with approved materials, in layers of 150 to 200 mm, watered and compacted as specified for the subgrade.

The excavation shall be finished neatly, smoothly and evenly to the correct lines, grades, sections as shown in the drawings or approved by , and evenly to the correct lines, grades, and sections as shown in the drawings or approved by the Engineer.

5.5.2 Earthwork in Subgrade

The Subgrade shall be formed of approved soil excavated from road trenches and stacked separately.

Profiles of subgrade shall be set up with stout poles to mark the centre and edges of the formation with the top levels of formation clearly marked by paint or cut and the slopes with strings and pegs at every 10 metres on straight portions.

Subgrade material shall be placed in successive horizontal layers of 200 mm depth extending to the full width of the Subgrade/trench to allow compaction of the full specified section to 150 mm using mini rollers/tampers/plate vibrators till the soil is evenly compacted to 95% of Proctor density with 2% variation in optimum moisture content. Before placing the next layer of 200 mm, the surface of the underlayer shall be moistened and scarified with pick axes or spades to provide a satisfactory bond with the next layer. The next layer shall also be compacted to a depth of 150 mm across the full width of the trench section, until the soil is evenly compacted to 95% of the Proctor density, with a 2% variation in optimum moisture content.
When boulders, broken stones, and similar hard materials are mixed with the embankment materials, care shall be taken to ensure that they are distributed uniformly throughout the bank and that no hollows are left near them. No stone or hard material shall project above the top of any layer. Each layer of embankment shall be watered, levelled, and compacted as specified before the succeeding layer is placed. The surface of the embankment shall be maintained at all times during construction at a cross fall that sheds water and prevents ponding.

If the soil contains less than the optimum moisture, water shall be added to the loose layers of the subgrade to uniformly bring the moisture up to the required level. If the material contains more than the required moisture, it shall be allowed to dry until the moisture is reduced to the required extent. The moistured or dried loose layers shall be compacted using a vibratory roller or mini roller or plate vibrator or tampered to achieve a compaction level of 95% of the Proctor density.

5.6 Compaction with Sand/stone dust

To achieve better compaction and a compacted surface before laying the GSB layer, two layers of sand and stone dust shall be laid and compacted to a depth of 150 mm each.

5.7 Preparation of Granular Sub-base (GSB)

Spreading and Compacting: The granular sub base material of **grade-iii** as specified in **Table 5.2: Gradation for coarse graded granular Sub base** (As per Table 400–1 of MORTH Specifications) shall be spread on the prepared sub grade maintaining the required slope and grade during the operation or other means as approved by the Engineer or as per applicable MORTH Specifications. The work shall be done as per Clause 401 MORTH V revision and as per BOQ provisions.

When the subbase material consists of a combination of materials mentioned in clause 401.2, mixing shall be done mechanically by the mix-in-place method.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small – sized jobs. The equipment used for mix-in-place construction shall be rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS: 2720 (part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS: 2720 (part 8). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means like disc harrows, rotavators until the layer is uniformly wet.

Rolling shall be continued until the density achieved is at least 98 percent of the maximum dry density for the material, as determined in accordance with IS: 2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material.
All loose, segregated, or otherwise defective areas shall be made good to the full thickness of the layer and re-compacted.

5.8 Wet mix Macadam Course (WMM)

The GSB layer surface over which Wet Mix Macadam (WMM) is to be laid shall be prepared to the specified grade and camber, and made free of dust and other extraneous materials.
Any ruts or soft, yielding areas shall be corrected in an approved manner and compacted until firm. WMM. sub-base course of specified thickness shall be provided. The course aggregate for this shall conform to requirements in **Table-5.7: Grading Requirements of Coarse Aggregates for Wet Mix Macadam (WMM)** (As per Table 400-13 of MORTH Specifications).

Table – 5.7: Grading Requirements of Coarse Aggregates for Wet Mix Macadam (WMM) (As per Table 400-13 of MORTH Specifications)

IS Sieve Designation	Percent by weight passing the IS sieve
53.00 mm	100
45.00 mm	95 – 100
26.50 mm	-
22.40 mm	60-80
11.20 mm	40-60
4.75 mm	25-40
2.36 mm	15-30
600.00 micron	8-22
75.00 micron	0-8

5.8.1 Preparation of WMM layer

Preparation of mix: Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/positive mixing arrangement like pugmill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixers.

Optimum moisture for mixing shall be determined in accordance with IS: 2720 (Part-8) after replacing the aggregate fraction retained on 22.4 mm sieve with material of 4.75 mm to 22.4 mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

Spreading of mix: Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared subgrade /sub- base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread either by a paver finisher or motor grader. For portions where mechanical means cannot be used, manual means as approved by the Engineer shall be used so as to achieve the specified slope and grade. The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

Compaction: After the mix has been laid to the required thickness, grade and crossfall/camber the same shall be uniformly compacted, to the full depth with suitable vibratory roller. The speed of the roller shall not exceed 5 km/h. The work shall be done as per Clause 406 MORTH V revision and as per BOQ provisions.

5.9 Primer coat

Primer: The choice of a bituminous primer shall depend upon the porosity characteristics of the surface to be primed as classified in IRC: 16. Surface of low porosity; such as wet mix macadam. The primer shall be bitumen emulsion.

Primer viscosity: The type and viscosity of the primer shall comply with the requirements of IS 8887, as sampled and tested for bituminous primer in accordance with these standards. Guidance on viscosity and rate of spray is given in Table-5.8: Requirement of Viscosity and quantity of Liquid bituminous Primer (As per Table 500-1 of MORTH Specifications).

Table-5.8: Selection Criteria for Viscosity-Graded (VG) Paving Bitumens based on Climatic conditions (As per Table 500-1 of MORTH Specifications)

Lowest Daily Mean Air Temperature, °C	**Highest Daily Mean Air Temperature, °C**		
	Less than 20 °C	20 to 30 °C	More than 30 °C
More than -10 °C	VG-10	VG-20	VG-30
-10 °C or lower	VG-10	VG-10	VG-20

Providing and applying primer coat with S.S. bitumen emulsion on prepared surface of granular base such as WMM including cleaning of road surface and spraying primer at the rate of 0.60 kg/sqm using mechanical means complete as per specifications The work shall be done as per Clause 502 MORTH V revision and as per BOQ provisions.

Preparation of road surface: The surface to be primed shall be prepared in accordance with Clauses 501.8. and 902 as appropriate. Immediately prior to applying the primer the surface shall be carefully swept clean of dust and loose particles, care being taken not to disturb the interlocked aggregate. This is best achieved when the surface layer is slightly moist (lightly sprayed with water and the surface allowed to dry) and the surface should be kept moist until the primer is applied.

Application of bituminous primer: The viscosity and rate of application of the primer shall be as specified in the Contract, or as determined by site trials carried out as directed by the Engineer. The bituminous primer shall be sprayed uniformly in accordance with Clause 501 of MORTH specifications. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

Curing of primer and opening to traffic: A primed surface shall be allowed to cure for at least 24 hours or such other period as is found to be necessary to allow all the volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with an application of sand, using the minimum quantity possible. The work shall be done as per BOQ provisions.

5.10 Tack Coat

Over the primed surface, a tack coat should be applied in accordance with Clause 503 of MORTH Specifications.

The binder used for tack coat shall be bitumen emulsion complying with IS 8887 of a type and grade as specified in the Contract or as directed by the Engineer.

The tack coat distributor shall be a self-propelled or towed bitumen pressure sprayer, equipped for spraying the material uniformly at a specified rate. Hand spraying of small areas, inaccessible to the distributor, or in narrow strips, shall be performed using a pressure hand sprayer or as directed by the Engineer.

The surface on which the tack coat is to be applied shall be clean and free from dust, dirt, and any extraneous material, and be otherwise prepared in accordance with the requirements of Clauses 501.8 and 902 as appropriate. Immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom, and high-pressure air jet, or by other means as directed by the Engineer.

The application of tack coat shall be at the rate specified in the Contract, and shall be applied uniformly. If rate of application of Tack Coat is not specified in the contract then it shall be at the rate specified in Table-5.9: Requirement of Viscosity and quantity of Liquid bituminous Tack Coat (As per Table 500-5 of MORTH Specifications).

Table-5.9: Requirement of Viscosity and quantity of Liquid bituminous Tack Coat (As per Table 500-5 of MORTH Specifications).

Sl No	Type of Surface	Quantity of Liquid bituminous material in Kg per sq.m.area
i)	Normal bituminous surfaces	0.20 to 0.30
iii)	Granular surfaces treated with primer	0.25 to 0.30
iv)	Non bituminous surfaces Cement concrete pavement	0.30 to 0.35

The normal range of spraying temperature for a bituminous emulsion shall be 20°C to 70°C and for a cutback, 50°C to 80°C. The work shall be done as per Clause 503 MORTH V revision and as per BOQ provisions.

5.11 Bituminous Macadam

The bitumen shall be paving bitumen of Penetration Grade complying with Indian Standard Specifications for "Paving Bitumen" IS:73.
Aggregate grading and binder content: When tested in accordance with IS: 2386 Part 1 (wet sieving method), the combined aggregate grading for the particular mixture shall fall within the limits shown in Table-5.10: Composition of Bituminous macadam (BM) (As per Table 500-7 of MORTH Specification) for the grading specified in the Contract. The type and quantity of bitumen, and appropriate thickness, are also indicated for each mixture type.

The aggregates shall be proportioned and blended to produce a uniform mixture complying with the requirements of Table 500-7.

Table-5.10: Composition of Bituminous macadam (BM)
(As per Table 500-7 of MORTH Specification)

Mix designation Nominal aggregate size Layer thickness	Grading 1 40mm 80 -100mm	Grading 2 19 mm 50 - 75 mm
IS Sieve (mm)	Cumulative % by weight of total aggregate passing	
45	100	
37.5	90-100	
26.5	75-100	100
19	-	90-100
13.2	35-61	56-88
4.75	13-22	16-36
2.36	4-19	4-19
0.3	2-10	2-10
0.075	0-8	0-8
Bitumen content, % by weight of total mixture[1]	3.1 - 3.4	3.3 - 3.5
Bitumen grade	35 to 90	35 to 90

5.11.1 Preparation of the Base

The base on which bituminous macadam is to be laid shall be prepared, shaped and compacted to the required profile in accordance with Clause 501.8 and 902.3 as appropriate, or as directed by the Engineer.

5.11.2 Preparation and transportation of the Mixture

The provisions of Clauses 501.3 and 501.4 shall apply.

5.11.3 Spreading

The provisions of Clauses 501.5.3 shall apply.

5.11.4 Compaction

Compaction shall be carried out in accordance with the provisions of Clause 501.6 and 501.7. The details of mixing, laying and rolling temperature of BM mix is as indicated in **Table-5.11:** Mixing, Laying and Rolling Temperatures for Bituminous Mixes (Degree celcius) (As per Table 500-2 of MORTH Specifications)
Rolling shall be continued until the specified density is achieved, or where no density is specified, until there is no further movement under the roller. The required frequency of testing is defined in Clause 903.

Table-5.11: Mixing, Laying and Rolling Temperatures for Bituminous Mixes (Degree Celsius) (As per Table 500-2 of MORTH Specifications)

Bitumen Viscosity grade	Bitumen Temperature (°C)	Aggregate Temperature (°C)	Mixed Material Temperature(°C)	Rolling Temperature (°C)	Laying Temperature (°C)
VG-40	160-170	160-170	160-170	100 Min	150 Min
VG-30	150-165	150-170	150-165	90 Min	140 Min
VG-20	145-165	145-170	145-165	85 Min	135 Min
VG-10	140-160	140-165	140-160	80 Min	130 Min

The bituminous macadam shall be covered with either the next pavement course or wearing course, as the case may be, within a maximum of forty-eight hours. If there is to be any delay, the course shall be covered by a seal coat to the requirement of Clause 513 before opening to any traffic. The seal coat in such cases shall be considered incidental to the work and shall not be paid for separately. The work shall be done as per Clause 504 MORTH V revision and as per BOQ provisions.

5.12 Bituminous Concrete

This work shall consist of construction in a single layer of bituminous concrete on a previously prepared Bituminous Macadam (BM) surface. The work shall be done as per Clause 507 MORTH V revision and as per BOQ provisions.

Bitumen: The bitumen shall be paving bitumen of Penetration grade complying with Indian Standard Specification for Paving Bitumen, IS: 73 and of the penetration indicated in Table 500-17, for bituminous concrete. The coarse aggregates shall be generally as specified in Clause 507.2.2, except that the aggregates shall satisfy the physical requirements of Table 500-17.

Requirements for the mixture: Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table-5.12: Composition of Bituminous Concrete (As per Table 500-17 of MORTH Specifications) and Table-5.13: Requirement of Bituminous Concrete (As per Table 500-11: of MORTH Specifications).

Table-5.12: Composition of Bituminous Concrete (As per Table 500-17 of MORTH Specifications)

Grading	**1**	**2**
Nominal aggregate size	19 mm	13.2 mm
Layer Thickness	50 mm	30-40 mm
IS Sieve[1] (mm)	**Cumulative % by weight of total aggregate passing**	
45		
37.5		
26.5	100	
19	90-100	100
13.2	59-79	90-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-27	26-38
0.3	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumen content % by mass of total mix[2]	Min 5.2	Min 5.4

Notes: 1. The combined aggregate grading shall not vary from the low limit on one sieve to the high limit on the adjacent sieve.
2. Determined by the Marshall method.
3. Job mix formula shall be generally as specified in Clause 507.3.3 and the results of tests enumerated in Table 500-19.

Table-5.13: Requirement of Bituminous Concrete
(As per Table 500-11: of MORTH Specifications)

Properties	**Viscosity Grade Paving Bitumen**	**Modified Bitumen**		**Test Method**
		Hot climate	**Cold climate**	
Compaction level	75 blows on each face of specimen			
Minimum stability (kN at 60 °C)	9.0	12.0	10.0	AASHTO T245
Marshall flow (mm)	2-4	2.5-4	3.5-5	AASHTO T245
Marshall Quotient (Stability/Flow)	2-5	2.5-5		MS-2 and ASTM D2041

% Air voids	3-5	
% Voids Filled with Bitumen (VFB)	65-75	
Coating of aggregate particle	95% minimum	IS: 6241
Tensile strength ratio	80% minimum	AASHTO T283
% Voids in Mineral Aggregate (VMA)	Minimum percent voids in mineral aggregate (VMA) are set out in Table 500-12 of MORTH	

5.12.1 Rolling

Immediately after the spreading of mix it shall be thoroughly compacted by rolling with vibratory rollers moving at a speed not more than 5 km per hour. Rolling shall be continued till the mix is thoroughly compacted to meet the general provisions of clauses 501.6 and 501.7.

5.12.2 Opening to Traffic

Traffic shall be allowed on the road after a lapse of minimum 24 hours, preferably 48 hours after laying as approved by the Employer's Representative.

5.13 Quality Control of Road restoration works

5.13.1 General

To ensure the requisite quality of construction, the materials and works shall be subjected to quality control tests, as described below. The testing frequencies set forth are the desirable minimum. The Engineer shall have the full authority to increase the frequencies of tests as he may deem necessary to ensure that the materials and works comply with the appropriate Specifications.

Test procedures for the various quality control tests are indicated in the respective Sections of these Specifications or for certain tests within this Section. Where no specific testing procedure is specified, the tests shall be carried out in accordance with the prevailing accepted engineering practice, subject to the approval of the Engineer.

5.13.2 Tests on Earthwork for Embankment and Subgrade Construction

(i) Sand content [IS:2720 (Part IV)]
1-2 tests per 8000 cu. metres of soil or as per MORTH.

(ii) Plasticity Test [IS:2720 (Part V)]
Each type to be tested, 1-2 tests per 8000 cu. metres of soil or as per MORTH.

(iii) Density Test [[IS:2720 (Part VII)].

Each soil type to be tested, 1-2 tests per 8000 cubic metres of soil or as per MORTH.

(iv) Deleterious Content Test [IS:2720 (PartXXVII)]
As and when required by the Engineer.

(v) Moisture Content Test [IS:2720(Part II)]
One test for every 250 cubic metres of soil or as per MORTH.

(vi) CBR Test on materials to be incorporated in the subgrade on soaked/unsoaked samples [IS:2720 (part XVI)]
One test for every 3000 m^3 at least or closer as and when required by the Engineer or as per MORTH.

5.13.3 Compaction control:

Control shall be exercised by taking at least one measurement of density for each 500 square metres of compacted area, or closer as required to yield the minimum number of test results for evaluation a day's work on statistical basis. The determination of density shall be in accordance with IS:2720 (part XXVIII). Test's locations shall be chosen only through random sampling techniques. Control shall not be based on the result of any one test but on the mean value of a set of 5-10 density determinations. The number of tests in one set of measurements shall be 5 as long as it is felt that sufficient control over borrow material and the method of compaction is being exercised. If considerable variations are observed between individual density results, the minimum number of tests in one set of measurement shall be increased to 10. The acceptance of work shall be subject to the condition that the mean dry density equals or exceeds the specified density and the standard deviation for any set of results is below 0.08 gm/cc.

However, for earthwork in subgrade and in top 500 mm portion of the embankment below the subgrade, at least one density measurement shall be taken for every 100 square metres of the compacted area provided further `that the number of tests in each set of measurements shall be at least 10. In other respects, the control shall be similar to that described earlier.

5.13.4 Tests on Granular Subbase (GSB) and Wet mix macadam (WMM) layers

The tests and their frequencies for the different types of bases and sub-base shall be as given in **Table 5.14**.

Table –5.14: Control Tests and their frequencies for Granular Sub base (GSB) and Wet mix macadam (WMM) layers

Sl.No.	Types of Construction	Test	Frequency***
1.	Granular sub-base	i) Gradation	One test per 200 m^3
		ii) Atterbergs limit	One test per 200 m^3
		iii) Moisture content prior to compaction	One test per 250 m^2
			One test per 500 m^2
		iv) Density of compacted layer	As required
		v) Deleterious constituents	As required
		vi) C.B.R	

Sl.No.	Types of Construction	Test	Frequency***
2.	Lime/Cement Stabilised	i) Purity of lime (for lime-soil stabilization	One test for each consignment, subject to a minimum of one test per 5 tonnes of lime.
		ii) Lime/Cement content	Regularly, through procedural checks.
		iii) Degree of pulverisation	Periodically as considered necessary.
		iv) CBR test on a set of 3 specimens	As required
		v) Moisture content prior to compaction	One test per 250 m^3.
		vi) Density of compacted layer	One test per 500 m^2
		vii) Deleterious constituents	As required
3	Wet mix Macadam	i) Aggregate Impact Value	One test per 200m^3 of aggregate
		ii) Grading	One test per 100 m^3 of aggregate
		iii) Flakiness Index	One test per 200 m^3 of aggregate
		iv) Atterberg limits of portion of aggregate passing 425 micron sieve	One test per 100 m^3

***** Or as per MORTH**

5.13.5 Tests on Bituminous Constructions

The tests and their frequencies for the different types of bituminous works shall be as given in **Table - 5.15** hereunder.

Table – 5.15: Control Tests and their Frequency for Bituminous Works

Sl. No.	Types of Construction	Test	Frequency
1.	Prime Coat/Tack Coat	i) Quality of binder	As Required
		ii) Binder temperature for an application	At regular close intervals
		iii) Rate of spread of binder	Two tests per day

Sl. No.	Types of Construction	Test	Frequency
2	Bituminous macadam (BM) / Bituminous Concrete (BC)	i) Quality of binder	As required
		ii) Aggregate impact value, flakiness index, and stripping value of aggregates	One test per 50-100m^3 of aggregate
		iii) Mix-grading	One set of test on individual constituents and mixed aggregates from the dryer for each 100 tonnes of mix subject to a maximum of two sets per plant per day.
		iv) Control of temperature of binder in boiler, aggregate in the dryer and mix at the time of laying and rolling	At regular close interval.
		v) Stability of mix (vide ASTM:D-1559)	For each 100 tonnes of mix produced, a set of three Marshall specimens to be prepared and tested for stability, flow value density, and void content, subject to a minimum of two sets being tested per plant per day.
		vi) Binder content and gradation in the mix (Binder content test vide ASTM:D-2172)	One test for each 100 tonnes of mix subject to a minimum of two tests per day per plant.
		vii) Rate of spread of mixed material	Regular control through checks on the weight of mixed material and layer thickness.
		viii) Density of compacted layer	One test per 250 m^2 area

5.14 Slab Culvert

Slab culverts shall be constructed at the specified locations of the existing cross-drainage works, as per the drawings or as directed by the Engineer. The Concrete works specifications for the construction of RC slab and the rubble masonry specifications for the supporting rubble walls are given in chapter 4 and chapter 8, respectively, and they shall be followed.

5.14.1 Bitumen at Location of Contact

The Bitumen to be used on the top of the bed concrete at the location of contact of RCC slab above in two coats, shall be straight run bitumen of specified grade.

5.14.2 Graded Gravel Free Draining Backfill

On each side of the uncoursed rubble walls supporting the slab culvert, a free-draining backfill of thickness 200 mm shall be provided. The material for this backfill shall be granular consisting of sound, tough, durable particles of crushed or uncrushed gravel, crushed stone or brickbats which will not become powdery under loads and in contact with water. The material shall be free from soft, thin, elongated or laminated pieces and vegetable or other deleterious substances. It shall be graded and meet the grading requirements specified in Table 5.10 below.

Table 5.10

Sieve Designation	Percent Passing by Weight
10 mm	100
4.75 mm	30-65
425 microns	5-30
150 microns	0-10

5.14.3 Weep Holes

Weep holes as shown on the drawings or as directed by the Engineer shall be provided in the masonry to drain water from the backfilling. Weep holes shall be of asbestos-cement pipes conforming to IS 6908 in rubble walls, with a necessary M10 concrete cushioning, 75 mm thick. They shall extend through the full width of the masonry at a spacing of 1.5 m c/c and with slope of about 1 vertical to 20 horizontals (or as shown on the drawings) towards the draining face.

5.15 Pipe Drains

Wherever required, pipe drains shall be provided for cross drainage purposes. The sequence of construction shall be as follows:

(a) laying of sand/shingle bedding on the original ground,
(b) laying of PCC of M10 grade,
(c) laying of concrete pipes of NP3 class as per IS 458,
(d) Constructing embankment above in compacted murum, laying of the sub-base and Wet mix Macadam as specified herein above.

The details of above works as directed by Engineer shall be followed.

5.15.1 Materials for Pipe Drains

All materials used in the construction of pipe drains shall conform to the requirements of the Specifications. RCC pipes of NP3 class shall conform to IS 458.

Each consignment of cement concrete pipes shall be inspected, tested if necessary, and approved by Engineer at the place of manufacture or at site before their incorporation in the Works.

5.15.2 Excavation for pipes

The foundation bed for pipe drain shall be executed true to the lines and grades shown on the drawings or as directed by the Engineer. The pipes shall be placed in a shallow excavation of the natural ground in open trenches cut into the existing embankment, lowered to the levels as shown in the drawings. Where trenching is involved, its width on either side of the pipe shall not be less than 200 mm nor more than one-third the diameter of the pipe. The sides of the trench shall be as nearly vertical as possible.

When during excavation, the material encountered is soft, spongy or other unstable soil, unless other special construction methods are called for as indicated on drawings, such unsuitable material shall be removed upto a depth of 600 mm or as directed by the Engineer. Before placing any backfill material, the exposed surface of the soft soil shall be lightly compacted with one pass of a 0.5 T roller. On the lightly compacted surface, coarse sand and shingle shall be spread in two successive layers of 300 mm and each layer shall be compacted by rolling with a min.0.5 T roller and with a minimum of 10 passes each, both in longitudinal and transverse directions.

When bedrock or boulder strata are encountered, excavation shall be taken down at least 300 mm below the bottom level of the pipe as directed by the Engineer and space filled with approved sand and shingle and thoroughly compacted to provide adequate support for the pipes.

Trenches shall be kept free from water until the pipes are installed and the joints have been hardened. For this purpose, Contractor shall suggest necessary method for diverting the water.

5.15.3 Bedding for pipe

The bedding surface shall provide a firm foundation of uniform density throughout the length of the pipe drain and shall conform to the specified level and grade.

The pipe shall be bedded in a cradle of concrete having a mix not leaner than M-10. The pipes shall be laid on the concrete bedding before the concrete has set.

5.15.4 Laying of pipes

No pipe shall be placed in position until the foundations have been approved by the Engineer. When pipes are to be laid adjacent to each other, they shall be separated by a distance at least equal to or greater than half the diameter of the pipe, subject to a minimum of 450 mm.

The laying of pipes on the prepared concrete foundation shall commence at the outlet and proceed towards the inlet, being completed to the specified lines and grades. The pipes shall be fitted and matched so that when laid they form a drain with a smooth uniform invert.

Any pipe found to be defective or damaged during laying shall be removed at the Contractor's expense.

5.15.5 Jointing

All the joints shall be made with care so that their interior face is smooth and consistent with the interior surface of the pipes. The ends of the pipes should be so shaped as to form a self-centering joint with a jointing space 13 mm wide. The jointing space shall be filled with cement mortar (1 cement to 2 sand) mixed sufficiently dry to remain in position when forced with a trowel or rammer. Care shall be taken to fill all voids and excess mortar shall be removed. After finishing, the joints shall be kept covered and damp for at least four days.

5.15.6 Backfilling

Trenches shall be backfilled with selected murum as per the specifications given in this part. Backfilling up to 0.3 metres above the top of the pipe shall be carefully done, and the murum shall be thoroughly consolidated under the haunches of the pipe.

5.16 Measurement

5.16.1 Slab Culvert

(a) Measurement of in-situ concrete work shall be as specified in chapter 4 of this specification.

(b) Measurement of masonry shall be as specified in chapter 8 of this specification.

(c) Bitumen at locations of contact with concrete surface shall be measured in square metres over area covered in plan and the rates shall include cleaning the surfaces, applying in two coats, etc., as specified.

(d) Graded gravel free draining backfill shall be measured in cubic metres and the rate shall include supplying, backfilling, etc., as specified.

(e) Measurement for weep holes shall be running metres and the rates shall include providing and fixing in rubble masonry walls with necessary concrete cushioning to lines and levels as specified.

5.16.2 Pipe Drains

Ancillary works such as excavation, backfilling, laying P.C.C below pipe, etc., shall be paid for separately, as provided under respective clauses.

End of Chapter-5

CHAPTER 6

STRUCTURAL STEEL WORK

CHAPTER 6

STRUCTURAL STEEL WORK

6.1 Applicable Codes and Specifications

The supply, fabrication, erection and painting of structural steel works shall comply with the following specifications, standards and codes unless otherwise specified herein. All standards, specifications and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

1.	IS: 808	Dimensions for Hot Rolled Steel sections
2.	IS: 814	Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Maganese Steel
3.	IS: 800	Code of Practice for General Construction in Steel
4.	IS: 801	Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members in General Building Construction
5.	IS: 806	Code of Practice for Use of Steel Tubes in General Building Construction
6.	IS: 7205	Safety Code for Erection of Structural Steel Work
7.	IS: 7215	Tolerances for Fabrication of Steel Structures
8.	IS: 4000	High Strength Bolts in Steel Structure – Code of Practice
9.	AISC	Specifications for Design, Fabrication and Erection of Buildings
10.	IS: 1161	Steel Tubes for structural purposes
11.	IS:102	Ready Mixed paint, Brushing, Red Lead, Non-setting, Priming.
12.	IS:110	Ready Mixed paint, brushing, grey filler for enamels for use over primers.
13.	IS:117	Ready Mixed paint, Brushing, Finishing, Exterior Semigloss for general purposes, to Indian Standard colours.
14.	IS:158	Ready Mixed paint, Brushing, Bituminous, Black, Lead free, Acid, Alkali and heat resisting.
15.	IS:159	Ready Mixed paint, Brushing, Acid resisting for protection against acid fumes, colour as required.
16.	IS:341	Black Japan, Types A, B and C
17.	IS:2339	Aluminium paint for general purposes, in Dual container
18.	IS:2932	Specification for enamel, synthetic, exterior, type 1, (a) undercoating, (b) finishing
19.	IS:2933	Specification for enamel, exterior, type 2, (a) undercoating, (b) finishing
20.	IS:5905	Sprayed aluminium and zinc coatings on Iron and Steel.
21.	IS:6005	Code of practice for phosphating of Iron and Steel.
22.	IS:9862	Specification for ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water & chlorine resisting.
23.	IS:13183	Aluminium paint, Heat resistant.
24.	SIS-05-5900	(Swedish Standard)
25.	IS: 1239	Mild steel tubes, tubulars and other Wrought steel fittings Part 1 – Mild steel tubes Part 2 – Mild steel tubulars and other wrought steel pipe fittings

26.	IS : 1363 (Parts 1 to 3)	Hexagon Head Bolts, Screws and Nuts of product Grade C (Size range M5 to M64)
27.	IS : 1367 (All parts)	Technical Supply Conditions for Threaded Fasteners
28.	IS : 1852	Rolling and Cutting Tolerances for Hot Rolled Steel Products
29.	IS : 1977	Structural Steel (Ordinary Quality)
30.	IS : 2062	Steel for General Structural Purposes
31.	IS : 2074	Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and Priming
32.	IS : 3502	Steel Chequered Plate
33.	IS : 3757	High Strength Structural Bolts
34.	IS : 5369	General Requirements for Plain Washers and Lock Washers
35.	IS : 5372	Taper Washers for Channels
36.	IS : 5374	Taper Washer for 1 Beams
37.	IS : 6610	Heavy Washers for Steel Structures
38.	IS : 8500	Structural Steel-microalloyed (medium and high strength qualities)
39.	IS : 803	Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded storage tanks
40.	IS : 816	Code of Practice for use of Metal Arc Welding for General construction in Mild Steel
41.	IS : 822	Code of Procedure for Inspection of Welds
42.	IS : 1182	Recommended Practice for Radiographic examination of Fusion – Welded Butt Joints in Steel Plates
43.	IS : 1200	Method of Measurement in Building Civil Works
44.	IS : 1477	Code of Practice for Painting of (Parts 1&2) Ferrous Metals in Buildings
45.	IS : 2595	Code of Practice for Radiographic Testing
46.	IS : 3658	Code of Practice for Liquid Penetrant Flaw Detection
47.	IS : 5334	Code of Practice for Magnetic Particle Flaw Detection of Welds
48.	IS : 9595	Recommendations for Metal Arc Welding of Carbon and Carbon Manganese Steel
49.	IS : 1367	Technical, Supply, Conditions for steel (Part 13) threaded fasteners
50.	IS : 1573	Electroplated Coating of Zinc on Iron and Steel
51.	IS : 2629	Recommended Practice for Hot Dip Galvanising of Iron and Steel
52.	IS : 2633	Method of Testing Uniformity of Coating on Zinc Coated Articles
53.	IS : 4736	Hot Dip Zinc coating on Mild steel tubes
54.	IS : 4759	Hot Dip Zinc coating on Structural Steel and other Allied products
55.	IS : 5905	Sprayed Aluminium and Zinc Coatings on Iron and Steel
56.	IS : 6158	Recommended Practice for Safeguarding against Embrittlement of Hot Dip Galvanised Iron and Steel
57.	IS : 6159	Recommended Practice for Design and preparation of Material Prior to Galvanising
58.	IS : 6745	Methods for Determination of Weight of Zinc Coating on Zinc coated Iron and Steel Articles

6.2 Steel Materials

Steel materials shall comply with the codes referred to in Sub-Clause 6.1.
All materials used shall be new, unused and free from defects.

Steel conforming to IS:1977 shall be used only for the following:

Fe310-0(St 32-0)	For general purposes such as door/window frames, grills, steel gates, handrails, fence posts, tee bars and other non-structural use.
Fe410-0(St 42-0)	For structures not subjected to dynamic loading other than wind loads such as: Platform roofs, foot over bridges, building, factory sheds etc.
Fe10-0(St 42-0)	Grade steel shall not be used a) If welding is to be employed for fabrication b) If site is in severe earthquake zone c) If plastic theory of design is used

6.3 Drawings prepared by the Employer

Design drawings will be furnished to the Contractor and all drawings so furnished shall form a part of this specification in case of Item Rate Contracts. These design drawings prepared by the Engineer will show all the levels, forces on members, size and orientation of each member, location/size of openings to enable the Contractor to prepare drawings for fabrication and erection. It shall be clearly understood that these drawings are not intended to show connection details, thickness of members, cuts, notches, bends and such other details.

The Engineer reserves the right to make changes. Revisions to drawings, even after release for preparation of shop drawings, are very likely to be made to reflect additional data/details received and updated requirements. Revisions to drawings and any new drawings made to include additional work by the Contractor shall be considered a part of this specification and contract. The Employer shall not entertain any extra claims on this account.

Where the fabrication drawings are to be furnished by the Engineer, he will issue to the Contractor the required copies of such drawings in the sequence required for the fabrication of the components in the order they will be required to be erected at site. Such drawings will be issued in the required numbers for the Contractor to adhere to the project schedule.

Should the Contractor during the execution of his work, find discrepancies in the information furnished by the Engineer, he shall refer such discrepancies to the Engineer before proceeding with the work.

6.4 Drawings prepared by the Contractor

The Contractor shall prepare all fabrication and erection drawings for the entire work. All the drawings for the entire work shall be prepared in metric units. The drawings shall preferably be of one standard size and the details shown there in shall be clear and legible.

The Contractor shall not commence detailing unless Engineer's design drawings are officially released for preparation of shop drawings. The Contractor shall be responsible for the correctness of all fabrication drawings. The Contractor shall revise fabrication drawings to reflect all revisions in design drawings as and when the Engineer makes such revisions.

All fabrication drawings shall be submitted to the Engineer for approval.

No fabrication drawings will be accepted for the Engineer's approval unless they have been checked and approved by the Contractor's qualified structural engineer and accompanied by an erection plan showing the location of all detailed pieces. The Contractor shall ensure that connections are detailed to facilitate the ease of erection of structures and the making of field connections.

Fabrication shall commence only after the Engineer has approved the fabrication drawings. Approval by the Engineer of any of the drawings shall not relieve the Contractor from the responsibility for correctness of engineering and design of connections, workmanship, fit of parts, details, material, errors or omissions of any and all work shown thereon. The Engineer's approval shall constitute approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details.

The drawings prepared by the Contractor and all subsequent revisions etc. shall be at the cost of the Contractor for which no separate payment will be made.

6.5 Fabrication

6.5.1 General

All workmanship and finish shall be of the best quality and shall conform to the best approved method of fabrication. All materials shall be finished straight and shall be machined/ground smooth true and square where so specified. All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Unless otherwise approved by the Employer's Representative, reference may be made to relevant IS codes for providing standard fabrication tolerance. Material at the shops shall be kept clean and protected from weather.

6.5.2 Connections

Shop/field connections shall be as per approved fabrication drawings.

In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers are used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that at least one thread of the bolt projects beyond the nut, except in the case of high-strength friction-grip bolts, where this projection shall be at least three times the pitch of the thread.

In all cases where bearing is critical, the unthreaded portion of bolt shall bear on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt is required for this purpose.

All connections and splices shall be designed for full strength of members or loads. Column splices shall be designed for the full tensile strength of the minimum cross section at the splice.

All bolts, nuts, washers, electrodes, screws etc., shall be supplied/brought to site 10% above the requirement in each category and size. Rates shall cover the cost of this extra quantity.
All members likely to collect rain water shall have drain holes provided.

6.5.3 Straightening

All materials shall be straight and, if necessary, before being worked shall be straightened and/or flattened by pressure and shall be free from twists. Heating or forging shall not be resorted to without the prior approval of the Employer's Representative in writing.

6.5.4 Rolling and Forming

Plates, channels, R.S.J. etc., for circular bins, bunkers, hoppers, gantry girders, etc., shall be accurately laid off and rolled or formed to required profile/shape as called for on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

6.5.5 High Strength Friction Grip Bolting

Inspection after tightening of bolts shall be carried out as stipulated in the appropriate standards depending upon the method of tightening and the type of bolt used.

6.5.6 Welding

Welding procedure shall be submitted to the Employer's Representative for approval. Welding shall be entrusted to qualified and experienced welders who shall be tested periodically and graded as per IS 817, IS : 7310 (Part 1) and IS : 7318 (Part 1).

While fabricating plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the members. Wherever weld reinforcement interferes with proper fit-up between components to be assembled off welding, these welds shall be ground flush before assembly.

Approval of the welding procedure by the Employer's Representative shall not relieve the Contractor of his responsibility for correct and sound welding without undue distortion in the finished structure.

No welding shall be done when the surface of the members is wet nor during periods of high wind.

Each layer of a multiple-layer weld, except the root and surface runs, may be moderately peened with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from overpeening.

No welding shall be done on base metal at a temperature below -5 °C. Base metal shall be preheated to the temperature as per relevant IS codes.

Electrodes other than low-hydrogen electrodes shall not be permitted for thicknesses of 32 mm and above.

All welds shall be inspected for flaws by any of the methods described under Sub-clause 6.8.3. The method to be adopted shall be agreed upon with the Employer's Representative.

The correction of defective welds shall be carried out in a manner approved by the Employer's Representative without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means approved by the Employer's Representative shall be used to ensure that the whole of the crack and material upto 25 mm beyond each end of the crack has been removed. The Contractor shall bear the cost of all such tests and operations incidental to correction.

6.6 Tolerances

The dimensional and weight tolerances for rolled shapes shall be in accordance with IS : 1852 for indigenous steel and equivalent applicable codes for imported steel. The tolerances for fabrication of structural steel shall be as per IS : 7215.

Cutting, punching, drilling, welding, and fabrication tolerances shall be generally as per the relevant IS codes.

6.7 End Milling

Where compression joints are specified to be designed for bearing, the bearing surfaces shall be milled to ensure they are true and square, thereby ensuring proper bearing and alignment.

6.8 Inspection

6.8.1 General

The Contractor shall provide the Employer's Representative with due notice in advance of the works being made ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for the Employer's Representative's inspection. The

fact that certain material has been accepted at the Contractor's shop shall not invalidate final rejection at site by the Employer's Representative if it fails to conform to the requirements of these specifications, to be in proper condition or has fabrication inaccuracies which prevent proper assembly nor shall it invalidate any claim which the Employer may make because of defective or unsatisfactory materials and/or workmanship.

No materials shall be painted or despatched to site without inspection and approval by the Employer's Representative unless such inspection is waived in writing by the Employer's Representative.

The Contractor shall provide all the testing and inspection services and facilities for shop work except where otherwise specified.

For fabrication work carried out in the field, the same standard of supervision and quality control shall be maintained as in shop-fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the Employer's Representative.

Inspection and tests on structural steel members shall be as set forth below.

6.8.2 Material Testing

If mill test reports are not available for any steel materials, the Contractor shall test the same to the Employer's Representative's satisfaction to demonstrate conformity with the relevant specification.

6.8.3 Tests on Welds

6.8.3.1 Magnetic Particle Test

Where welds are examined by magnetic particle testing, such testing shall be carried out in accordance with relevant IS codes. If heat treatment is performed, the completed weld shall be examined after the heat treatment. All defects shall be repaired and retested. Magnetic particle tests shall be conducted using an alternating current. Direct current may be used with the permission of the Employer's Representative.

6.8.3.2 Liquid Penetrant Inspection

In the case of welds examined by Liquid Penetrant Inspection, such tests shall be carried out in accordance with relevant IS Code. All defects shown shall be repaired and rechecked.

6.8.3.3 Radiographic Inspection

All full strength butt welds shall be radiographed in accordance with the recommended practice for radiographic testing as per relevant IS code.

6.8.4 Dimensions, Workmanship & Cleanliness

Members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in accordance with the requirements shown in the Contractor's approved fabrication drawings.

6.8.5 Test Failure

In the event that any member fails to satisfy inspection or test requirements, the Contractor shall notify the Employer's Representative. The Contractor must obtain permission from the Employer's Representative before any repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the Employer's Representative.

The Employer's Representative has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the Employer, only in case of successful testing.

The Contractor shall maintain records of all inspection and testing which shall be made available to the Employer's Representative.

6.9 Shop Matching

For structures like bunkers, tanks, etc. shop assembly is essential. For other steel work, such as columns and tie beams/bracings, may need to be shop assembled to ensure satisfactory fabrication, obtain adequate bearing areas, etc., if so desired by the Employer's Representative. The Contractor shall carry out all these shop assemblies.

6.10 Marking of Members

After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be visible.

All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be clearly marked with a distinguishable paint to facilitate easy location.

Erection marks on like pieces shall be in identical locations. Members having lengths of 7.0 m or more shall have the erection mark at both ends.

6.11 Errors

Any error in shop fabrication which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified by the

Employer's Representative as defective workmanship. Where the Employer's Representative rejects such material or defective workmanship, the same shall be replaced by materials and workmanship conforming to these Employer's Requirements by the Contractor, at no cost to the Employer.

6.12 Site Operations

The Contractor shall complete all preliminary works at site well before the arrival of structural steel, such as establishment of a well equipped and adequately staffed site office, stores, unloading gantry, unloading pre-assembly yard, labour quarters if any, electrical and water connections, electrical winches, derricks, cranes, compressors, all tools and tackles, rivet guns, welding sets, torque wrenches, spud wrenches, staging, etc., as well as experienced erection and supervisory personnel as part of this contract and any other work that may be necessary to start erection immediately after the arrival of the first batch of steel on site.

The Contractor shall furnish at his own expense, the necessary non-inflammable staging and hoisting materials or equipment required for the erection work and shall remove and take them away after completion of the job. The Contractor shall also provide necessary passageways, fences, safety belts, helmets, lights and other fittings to the satisfaction of the Employer's Representative and to meet the rules of local authorities and for protection to his men and materials. A licensed electrician shall be kept on the job for the entire duration of the work to maintain the Contractor's electrical equipment and connections.

The Contractor shall protect all existing plant, structures, piping, conduits, equipment and facilities against damage during erection. Any damage caused by Contractor shall be rectified entirely at his cost, to the satisfaction of the Employer's Representative. If work has to be carried out adjacent to existing switch yards or electrical installations which are live, the Contractor must ensure suitable safety precautions in consultation with Employer's Representative.

If a portion of the work of the project area cannot be made available to the Contractor for his activities due to operations being carried out by other agencies, he shall suitably modify his sequence of operations so as to continue work without interruption. The Contractor shall work in co-ordination with other agencies working on the project site and plan his work suitably so as not to hinder the progress of construction at site.

6.13 Acceptance of Steel, its Handling & Storage

The Contractor shall carefully check the steel to be erected at the time of acceptance. Any fabrication defects observed should be brought to the notice of the Employer's Representative.

No dragging of steel shall be permitted. All steel shall be stored 300mm above ground on suitable packing to avoid damage. It shall be stored in the order required for erection, with erection marks visible. All storage areas shall be prepared and maintained by the Contractor. Steel shall not be stored in the vicinity of areas where excavation or grading will be done and,

if so stored temporarily, this shall be removed by the Contractor well before such excavation and/or grading commences to a safe distance to avoid burial under debris.

Scratched or abraded steel shall be given a coat of primer in accordance with these Employer's Requirements for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust/corrosion by suitable coating and also from damage.

6.14 Anchor Bolts & Foundations

The Contractor shall carefully check the location and layout of anchor bolts embedded in foundations constructed, to ensure that the structures can be properly erected as shown on the drawings. Any discrepancy in the anchor bolts/foundation shall be reported to the Employer's Representative.

Leveling of column bases to the required elevation may be done either by providing shims or three nuts on the upper threaded portion of the anchor bolt. All shim stock required for keeping the specified thickness of grout and in connection with the erection of structures on foundations, crane brackets, or at any other locations shall be of good M.S. plates and shall be supplied by the Contractor at his cost.

A certain amount of cleaning of the foundations and preparation of the area is considered normal and shall be carried out by the Contractor at no additional cost.

Where beams bear in pockets or on walls, bearing plates shall be set and levelled as part of the work. The Contractor will carry out all grouting under column base plates or beam bearing plates.

6.15 Assembly & Connections

Field connections may be affected by riveting, bolting, welding or by use of high strength friction grip bolts as shown on the design and erection drawings.

All field connection work shall be carried as per the drawings prepared by the Contractor. All bolts, nuts, washers, rivets, electrodes required for field connections shall be supplied by the Contractor.

All assembling shall be carried on a level platform.

Drifts shall be used only for drawing the work to proper position and must not be used to such an extent as to damage the holes. Size of drifts larger than the normal diameter of hole shall not be used. Any damaged holes or burrs must be rectified to the satisfaction of the Employer's Representative.

Corrections of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets shall be considered part of the erection process. Any error in the shop, which prevents proper fit on a moderate amount of reaming and slight chipping or cutting, shall be immediately reported to the Employer's Representative.

6.16 Erection

All structural steel shall be erected as shown on the drawings prepared by the Contractor. Proper size steel cable slings, etc., shall be used for hoisting. Guys shall not be anchored to existing structures, foundations, etc., unless so permitted by the Employer's Representative in writing. Care shall be taken to see that ropes in use are always in good condition.

Steel columns in the basement, if any, are to be lowered and erected carefully with the help of a crane and/or derrick without damaging the basement walls or floor.

Structural steel frames shall be erected plumb and true. Frames shall be lifted at points such that they are not liable to buckle and deform. Trusses shall be lifted only at node points. In the case of trusses, roof girders, all of the purlins and wind bracing shall be placed simultaneously and the columns shall be erected truly plumb on screed bars over the pedestals. All steel columns and beams shall be checked for plumb and level individually before and after connections are made. Temporary bracings shall be introduced wherever necessary to take care of all loads to which the structure may be subjected, including erection equipment and the operation thereof. Such bracings shall be left in place as long as may be required for safety and stability.

Chequered plates shall be fixed to supporting members by tack welding or by countersunk bolts as shown/specified in relevant drawings and/or as approved by the Employer's Representative. The edges shall be made smooth and no burrs or jagged ends shall be left. While splicing, care should be taken so that there is continuity in pattern between the two portions. Care should also be taken to avoid distortion of the plate while welding. The erection of chequered plates shall include:

(a) Welding of stiffening angles/vertical stiffening ribs
(b) Cutting to size and making holes to required shape wherever necessary to allow service piping and/or cables to pass through
(c) Splicing as shown in relevant drawings
(d) Smoothening of edges
(e) Fixing of chequered plates by tack welding or by countersunk bolts
(f) Providing lifting hooks for ease of lifting.

As erection progresses, the work shall be securely bolted to take care of all dead load, wind, seismic and erection stresses.

No riveting or welding or final bolting shall be done until the structure has been properly aligned and approved by the Employer's Representative. No cutting, heating or enlarging of the holes shall be carried out without the prior written approval of the Employer's Representative.

Test certificates shall be furnished by the Contractor.

6.17 Inspection

The Employer's Representative shall have free access to all parts of the job during erection and all erection shall be subjected to his approval. In case of faulty erection, all dismantling and re-erection required will be at the Contractor's cost. No paint shall be applied to rivet heads or field welds or bolts until these have been approved by the Employer's Representative.

6.18 Tolerances

6.18.1 General

Tolerances mentioned below shall be achieved after the entire structure or part thereof is in line, level and plumb.

6.18.2 Columns

Deviation of column axes at foundation top level with respect to true axes:

(a) In longitudinal direction	±5 mm
(b) In lateral direction	±5 mm

Deviation in the level of bearing surface of columns at foundation top with respect to true level	±5mm

Out of plumbness (verticality) of column axis from true vertical axis, as measured at column top:

(a)	For columns upto and including 15 metres in height	±1/1000 of column height in mm or ±15 mm whichever is less
(b)	For columns exceeding 15 metres in height	±1/1000 of column height in mm or ±20 mm whichever is less

Deviation in straightness in longitudinal and transverse planes of column at any point along the height	±1/1000 of column height in mm or ±10 mm whichever is less
Difference in erected position of adjacent pairs of columns along length or across width of building prior to connecting trusses/beams with respect to true distance	±10mm
Deviation in any bearing or seating level with respect to true level	±5 mm
Deviation in differences in bearing level of a member on adjacent pair of columns	±10 mm

both across and along the building

6.18.3 Trusses and Beams

Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord	±1/250 of height of truss in mm or ±15 mm whichever is less
Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss	±1/1500 of span of truss in mm or ±15 mm whichever is less
Lateral shift in location of truss from its true vertical position	±10 mm
Lateral shift in location of purlin true position	±5 mm
Deviation in difference of bearing levels of trusses or beams from the true difference	i) ±20 mm for trusses ii) For beams: Depth < 1800mm: ±6mm Depth > 1800mm: ±10mm
Deviation in sag in chords and diagonals of truss between node points	1/1500 of length in mm or 10mm whichever is smaller
Deviation in sweep of trusses, beams etc. in the horizontal plane	1/1000 of span in mm subject to a maximum of 10 mm

6.18.4 Crane Girders & Rails

Shift in the centre line of crane rail with respect to centre line of web of crane girder	±5 mm
Shift in plan of alignment of crane rail with respect to true axis of crane rail at any point	±5 mm
Difference in alignment of crane rail in plan measured between any two points 2 metres apart along rail	±1 mm
Deviation in crane track with respect to Time gauge	
(a) For track gauges upto and Including 15 metres	±5 mm

(b)	For track gauges more than 15 metres	± [5 + 0.25 (S-15)] where S in metres is true gauge
Deviation in the crane rail level at any point from true level		±1/1200 of the gauge distance or ±10mm whichever is less
Difference in the crane rail actual levels between any two points 2 metres apart along the rail length		±2 mm
Difference in levels between crane track Rails at		
(a)	Supports of crane girders	±15 mm
(b)	Mid span of crane girders	± 20 mm
Relative shift of crane rail surfaces at a joint in plane and elevation		2 mm subject to grinding of surfaces for smooth transition
Relative shift in the location of crane stops (end buffers) along the crane tracks with track gauge S in mm		1/1000 of track gauge S in mm subject to maximum of 20 mm

6.19 Clean up of Work Site

During erection, the Contractor shall at all times keep the working and storage areas used by him free from accumulation of waste materials or rubbish. Before completion of erection, he shall remove or dispose in a satisfactory manner all temporary structures, waste and debris and leave the premises in a condition satisfactory to the Employer's Representative.

6.20 Painting

6.20.1 General

After steel has been erected, all bare and abraded spots, rivet heads, field welds, bolt heads and nuts shall be spot painted with primer. Before paint is applied, the surface shall be dry and free from dust, dirt, scale and grease. All surfaces inaccessible after erection shall receive two coats of the approved paint before erection.

6.20.2 Surface Treatment

All the surfaces of steel work to be painted shall be thoroughly cleaned of all loose mill scale, rust, grease, dirt and other foreign matter. The workmanship shall generally conform to the requirements of IS 1477- Part I.

Oil and grease removal shall be carried out either by solvent cleaning or by using alkali type degreasing agents. To remove grease material the surface shall be cleaned with solvents containing emulsifier. After cleaning, the surface shall be washed with water. When the

surface has cement pelter or salts, the cleaning shall be done with strong alkalies. After cleaning, water rinsing and subsequent passivation by dilute chromic acid rinsing shall be carried out to ensure that no traces of alkali is left on the surface. The procedure for cleaning by above mentioned methods shall be as per manufacturer's instructions.

Derusting and descaling of steel shall be carried out either manually, mechanically or chemically.

6.20.2.1 Manual or Hand Tool Cleaning

Loose mill scale, loose rust and loose paint shall be removed by wire brushing, scrapping, chipping, rubbing with abrasive paper or steel wool. This method shall not be employed when the surface has firmly adhering mill scale. After hand tool cleaning, the surface shall be rubbed with sand paper so as to ensure that no loose material exists and the surfaces shall be dusted off.

6.20.2.2 Mechanical Cleaning

Power Tool Cleaning:

This shall be carried out by employing power operated wire brushes. Power tool cleaning shall be resorted to only if sand/shot blasting is not possible/permissible and high quality of surface preparation is required.

The surface prior to treatment shall have been cleaned of dust and grease and heavier layers of rust removed by chipping.

The powertool cleaning shall remove loose mill scale and rust by adopting very thorough scrapping, grinding and machine brushing. After the surfaces are cleaned by compressed air, it shall have a pronounced metallic sheen.

Flame Cleaning:

Hard mill scale and rust shall be removed through Oxy-acetylene flame. Trained workmen shall carry out the work to ensure that only mill scale is removed without heating the parent steel. The work shall be carried out carefully on welded surfaces so that the strength of weld is not affected due to heating.

6.20.2.3 Sand Blasting and Shot Blasting

Sand/shot blasting shall only be carried out after removal of grease, oil and other contaminants. The work shall be carried out by impinging under pressure of air, a jet of sharp sand or granulated steel (steel grits) on to the metal surface. The process shall ensure complete removal of rust and firmly adhering mill scale. Special care shall be taken on weld areas to remove flux and spatter. Blasting shall ensure an even colour of the surface and the surface shall have silver grey colour. Precautions shall be taken when sand or shot blasting of light gauge steel surfaces to ensure that buckling does not occur due to continuous impingement of sand or steel shots under high velocity.

Sand/shot blasting shall be adopted for structures which are exposed to corrosive conditions for which superior paint protection is to be adopted. The finished surfaces shall conform to the requirements of Sa 2.5 or Sa 3 as per Swedish Standard SIS-05-5900 as required.

As sand blasting causes dust nuisance, necessary clearance shall be obtained by the Contractor from the Competent authorities prior to commencing sand blasting.

6.20.2.4 Chemical Cleaning (Pickling)

The cleaning shall be done by pickling in sulphuric, hydrochloric or phosphoric acids. Pickling shall be carried out in accordance with the detailed procedure as given in IS 6005. Washing after pickling shall remove all traces of the acids. All workpieces shall be thoroughly inspected, with particular attention to inaccessible corners.

All surfaces shall be cleaned thoroughly as per manufacturer's specification before application of primer.

6.20.3 Materials

6.20.3.1 Primer Paint

Anti-corrosive primers shall be either lead-based or lead-free types. Red lead primer shall conform to IS 102 and red oxide zinc chrome primer shall conform to IS 2074.

6.20.3.2 Finish Paint

Epoxy primer and epoxy paint shall be of the type as specified from an approved manufacturer.

Chlorinated rubber-based paint shall be of the manufacturer as specified or any equivalent approved manufacturer.

All the materials shall be of the best quality from an approved manufacturer. The Contractor shall obtain prior approval of the Employer's Representative for the brand of manufacture and the colour/shade prior to procurement for usage in the works.

Primer and finish paints shall be compatible with each other to avoid cracking and wrinkling. As such it is recommended that the primer and finish paint shall be from the same manufacturer.

The colour and shade shall conform to IS Standards referred to in Appendix 'D' of IS 1477-Part II. To facilitate selecting the correct shade number from the available alternatives, the Contractor shall conduct trial painting in small patches, in consultation with and as approved by the Employer's Representative.

All paint delivered to the fabrication shop/site shall be ready mixed, in original sealed containers, as packed by the manufacturer. Thinner shall not be permitted for usage unless specifically approved so by the Employer's Representative.

Paints shall be stirred thoroughly to keep the pigment in suspension.

The Contractor shall arrange for testing of paints as per relevant Indian Standards in an approved laboratory whenever the Employer's Representative requires the tests to be carried out for each batch of paints. Test results shall be submitted to the Employer's Representative for approval.

6.20.4 Workmanship

The type and the number of coats of the primer paint and finish paint shall be as specified.

Painting shall be carried out only on thoroughly dry surfaces.

No painting shall be done in frosty/foggy weather or when the humidity is high enough to cause condensation on the surface to be painted. Paint shall not be applied when the temperature of the surface to be painted is at 5deg.C or lower.

Primers shall adhere to the surface firmly and offer a key to the subsequent coats.

Workmanship shall generally conform to requirements specified in IS:1477-Part II.

It is essential to ensure that immediately after the preparation of the surfaces, the first coat of primer paint is applied by brushing and worked well to ensure a continuous film. After the first coat has dried, a second coat of primer shall be applied by brushing.

Structural steel surfaces shall be given the first coat of primer at shop and the second coat after it is erected in position. Furthermore, any abraded surfaces of the first coat that occur during transport from the shop to the site and during erection shall be provided with a touch-up coat of primer.

The dry film thickness of each coat of primer shall be not less than 25 microns.

Application of finishing paints shall be carried out within the shortest possible time interval after primer, since the primer coats are too thin to give adequate corrosion protection of the steel surface over a long duration.

Filler coats shall be applied to fill dents and to obtain a smooth finish wherever necessary. Only factory-prepared filler suitable for steel work shall be used. Fillers prepared by whiting and linseed oil by craftsmen at site shall not be used. Application of filler shall be done with good `putty knife' and necessary skill. Filler applied shall be just sufficient to fill the depression or unevenness and it shall be restricted to the minimum. It shall be applied in thin layers. In filling depression or unevenness, as many coats as are necessary may be applied allowing each layer to dry hard. The hardened coat shall be cut down by wet rubbing before

the subsequent coat is applied. Where necessary, filler coats shall be applied over the undercoats also.

Painting shall be carried out either by brushing or by spraying. The Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer.

After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of paint of optimum thickness shall be applied by brushing/spraying with minimum of brush marks. The coat shall be allowed to hard-dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

The first finishing coat of paint shall be applied by brushing or by spraying and allowed to hard-dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing or by spraying.

At least 24 hours shall elapse between the applications of successive coats. Each coat shall vary slightly in shade and shall be approved by the Employer's Representative, prior to applying the next coat.

Minimum dry film thickness of each coat of finish paint of synthetic enamel shall be 25 microns. Minimum dry film thickness of other finish paints shall be as specified in the respective item of work.

The thickness of film shall be measured by an Elcometer to be supplied by the Contractor. The Contractor shall calibrate the Elcometer frequently for different settings. Necessary calibrating accessories should be kept ready for calibration / testing of the Elcometer at any time.

Epoxy primer and epoxy paint shall be applied within the specified pot life all as per recommendations of the manufacturer.

Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly.

Surfaces inaccessible after erection, including top surfaces of floor beams, supporting grating or chequered plate shall receive one additional coat of finish paint over and above the number of coats specified prior to erection.

Portion of steel members embedded/to be encased in concrete shall not be painted. Joints to be site welded shall have no shop paint for atleast 50mm from the welding zone. Similarly, the steel surfaces shall not be painted in areas where connection is by use of friction grip bolts. On completion of the joint, the surfaces shall receive the painting as specified.

Maintenance painting of steel structures will become necessary if the painting already carried out shows signs of chalking, hairline cracking, deep checking, fine checking, peeling, blistering and rusting. It is essential that same quality of paint as specified earlier need be

adopted to ensure compatibility. The general workmanship for maintenance painting shall conform as per Clause.7 of IS 1477 – Part II.

The Contractor shall provide suitable protection as necessary to prevent paint finishes from splashing on equipment, floors, walls, etc.

6.21 Method of Measurement

For the purpose of payment, the weight of the actual, completed structures shall be calculated from the approved drawings for different items of work. Contractor shall submit to Employer relevant material list containing weight of each item.

No allowance will be permitted for weights of rivets, bolts, washers, screws etc. in calculating the weight of the completed structure. No allowances will be permitted for galvanizing, welding or for rolling margins. One tonne for the purpose of payment shall mean One Metric Tonne i.e. 1000 kg.

The weight of a member made out of standard rolled sections such as beams, channels, angles, etc. shall be based on the weight of the member given in IS 808, without deducting for hole, notches, bevel cuts, etc. Where a component consists of a cut joist or channel, the full weight of the rolled section shall be considered only if more than half the depth of the section is used. Otherwise only half the section unit weight shall be taken. Deductions shall be made in the weight of gussets/plates including chequered plates for skew cuts, notches and openings of 900 sq.cm. or larger.

For gussets/plates used in trusses, bracings, columns, beams etc. the area shall be that of the minimum circumscribing rectangle, except as stated above.

The weight of any built-up member shall be separated into the weight of each component.

Erection bolts installed by erector may be left in position on completion of erection; however, no additional payment shall be made either for supply or use of such bolts. If erection bolts are removed after erection is complete, holes shall be plug welded and ground smooth. No extra payment shall be made for such plug welding.

Painting work shall not be measured separately, if primer painting and/or primer and finish painting is deemed to be included in the scope of the item of work of fabrication and erection of structural steel since the rate per tonne of steel is deemed to include for painting as specified.

In cases where primer and/or finish painting work as specified is carried out on erected structural steel executed by a different agency, the method of measurement for painting shall be on the basis of tonnage of steel erected. For this purpose, the tonnage of erected steel as certified for payment to the different agency shall be considered as the basis and no measurement will be carried out separately.

6.22 Galvanising of Structural Steel

6.22.1 Galvanising Plant

Prior approval shall be obtained from Employer / Engineer if galvanising is proposed to be carried out outside Contractor's plant.

6.22.2 Workmanship

After all shop work is complete, all structural materials shall be punched with the erection mark and be hot-dip galvanised. Before galvanising, the steel shall be thoroughly cleaned of any paint, grease, rust, acid or alkali or such other foreign matters as are likely to interfere with the galvanising process or with the quality and durability of the zinc coating. Pickling shall be very carefully done and shall be proper.

The weight of the zinc coating shall be at least 0.610 kg/sq.m unless specified otherwise. Stub members and members for grillage type footing shall have heavier zinc coating not less than 0.80 kg/sq.m.

The galvanised surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth, and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel, globules, spiky IS:2633 unless specified otherwise.

All galvanised members shall be treated with Sodium dichromate solution or an approved equivalent after galvanising, so as to prevent white storage stains.

Galvanising of each member shall be carried out in one complete immersion. Double dipping shall not be permitted. However, in case of members over 7.5 M long, the Contractor shall take prior approval of Engineer for double dipping. When the steel section is removed from the galvanising kettle, excess spelter shall be removed by 'bumping'.

Wherever galvanised bolts, nuts locknuts, washers, accessories etc. are specified, they shall be hot-dip galvanised. Spring washers shall be electro-galvanised. Excess spelter from bolts, nuts, etc. shall be removed by centrifugal spinning. Rechasing of bolt threads after galvanising shall not be permitted. Nuts, however, may be tapped, but not to cause appreciable rocking of the nuts on the bolts. Readily available GI nuts, bolts and washers conforming to galvanising requirements may also be used.

Defects in certain members indicating presence of impurities in the galvanising bath in quantities larger than that permitted by the specifications, or lack of quality control in any manner in the galvanising plant, shall render the entire production in the relevant shift liable to rejection.

Contractor shall ensure that galvanising is not damaged in transit. In the event of occurrence of any damages Contractor shall at his own cost adopt scrapping and regalvanising the member to satisfy the specific requirements.

End of Chapter-6

CHAPTER 7

WATER SUPPLY AND SANITARY WORKS

CHAPTER 7

WATER SUPPLY AND SANITARY WORKS

7.1 Applicable Codes

The following standards and codes are made a part of this Employer's Requirement. All standards, codes of practice referred to herein shall be the latest editions including all official amendments and revisions.

IS : 210	:	Specification for grey iron castings
IS : 269	:	Specification for Ordinary Portland cement
IS : 383	:	Specification for coarse and fine aggregates from natural sources for concrete
IS : 432	:	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement
IS : 456	:	Code of Practice for plain and reinforced concrete
IS : 458	:	Concrete Pipes (with and without reinforcement).
IS : 516	:	Methods of tests for strength of concrete
IS : 554	:	Dimensions for pipe threads where pressure tight joints are required on the threads.
IS : 651	:	Salt glazed stoneware pipes and fittings.
IS : 774	:	Flushing Cisterns for water closets and urinals (valveless siphonic type)
IS : 775	:	Cast iron brackets and supports for wash basins and sinks.
IS : 781	:	Sand-cast brass screw-down bib taps and stop taps for water services.
IS : 783	:	Code of practice for laying of concrete pipes.
IS : 1068	:	Electroplated coatings of nickel and chromium of iron and steel.
IS : 1077	:	Specification for common burnt clay building bricks
IS : 1786	:	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS : 1239	:	Mild steel tubes (Part I) and mild steel tubulars and other wrought steel pipe fittings (Part II)
IS : 1536	:	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
IS : 1626	:	Asbestos cement building pipes, gutters and fittings (spigot and socket types).
IS : 1703	:	Copper Alloy float valves (horizontal plunger type) for water supply purposes.
IS : 1726	:	Cast iron machine hole covers and frames.
IS : 1729	:	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 1742	:	Code of practice for buildings drainage
IS : 2116	:	Specification for sand for masonry mortars
IS : 2212	:	Code of practice for brickwork
IS : 2250	:	Code of practice for preparation and use of masonry mortars
IS : 2326	:	Automatic flushing cisterns for urinals
IS : 2470	:	Code of practice for design and construction of septic tanks (Parts I & II)
IS : 2556	:	Vitreous sanitary appliances (Part I to Part XV)
IS : 2963	:	Specification for copper alloy waste fittings for wash basins and sinks

IS : 3006	:	Specification for chemically resistant glazed stoneware pipes and fittings
IS : 3311	:	Waste plug and its accessories for sinks and wash basins
IS : 5455	:	Specification for cast iron steps for machine holes
IS : 4127	:	Code of Practice for laying of glazed stoneware pipes
IS : 3495	:	Methods of tests of burnt clay building bricks
IS : 4111	:	Code of practice for ancillary structures in sewerage system machine holes
IS : 5382	:	Specification for rubber sealing rings for gas mains, water mains and sewers
IS : 5329	:	Code of practice for sanitary pipe work above ground for buildings
IS : 5434	:	Non-ferrous alloy bottle traps for marine use

IS : 4985 : Specifications for Unplasticized PVC pipes for potable water supplies

IS : 7634 : Code of Practice for Plastic pipes selection, Handling, storage and installation for Potable water supplies

IS : 13592 : Specifications for Unplasticized Polyvinyl chloride pipes for soil and waste discharge system for inside and outside buildings including ventilation and rain water system

7.2 Sanitary Installation

The work shall be carried out complying in all respects with any specific requirements of the local body in whose jurisdiction the work is situated, and as approved by the Employer's Representative.

Any damage caused to the building, or to installations therein, either due to negligence on the part of the Contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the Contractor.

All sanitary and plumbing work shall be carried out by licensed plumbers.

All sanitary appliances including sanitary fittings, fixtures, toilet requisites shall be of size, and design as approved by the Employer's Representative.

All white glazed porcelain fixtures, such as wash basin, sink drain board, water closet pan, urinal, `P' trap, etc., shall have a hard, durable, white glazed finish. They shall be free from cracks and other glazing defects. No chipped porcelain fixtures shall be used.

Joints between iron and earthenware pipes shall be made perfectly air and water tight by caulking with neat cement mortar.

7.3 Indian Type Water Closet

This shall be the long pan pattern with separate footrests made of white glazed earthenware; white glazed vitreous china or of white glazed fire clay. The general requirements shall conform to IS:2556 (Parts III and X). Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush type. The flushing rim and inlet shall be of the self draining type. It shall have a weephole at the flushing inlet to the pan. The flushing inlet shall be in the

front, unless otherwise approved by the Employer's Representative. The inside of the bottom of pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth enable easy and quick disposal while flushing. The exterior surface shall be unglazed and sufficiently rough or grooved at right angles to the axis of the outlet. Pans shall be provided with a trap `P' or `S' type with a minimum 50 mm water seal and 50 mm dia. vent horn. Pan shall be laid at the correct location and level over a bed of lime concrete using brick aggregates (1 part lime mortar to 2 parts brick bats with lime mortar to 2 parts of sand) or cement-sand admixture as specified in the drawings.

7.4 European Type Water Closet

Water closets shall be either of white glazed earthenware, white grazed vitreous china or white glazed fire clay as specified and shall be of "Siphonic Wash down type" conforming to IS.2556 (Part VIII). The closets shall be of one piece construction with approved plastic/bakelite seat and cover. Each water closet shall have 4 fixing holes having a minimum diameter of 6.5 mm for fixing to floor and shall have an integral flushing rim of suitable type. It shall also have an inlet of supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. The water closet shall have a weephole at the flushing inlet.

Each water closet shall have an integral trap with either "S" or "P" outlet with at least 50 mm water seal. The water closets shall have an anti-siphonage 50 mm dia. vent horn on the outlet side of the trap. The inside of water closets and traps shall be uniform and smooth in order to ensure in efficient flush. The serrated part of the outlet shall not be glazed externally. The water closet when sealed at the bottom of the trap in line with the back plate, shall be capable of holding not less than 10 litres of water between the normal water level and the highest possible water level of the water closet installed.

7.5 Urinals

Urinals shall be of the bowl pattern, either flat back or angle back type lipped in front. They shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay, and of size as specified conforming to IS.2556 (Part VI). The urinals shall be of one piece construction. Each urinal shall be provided with not less than two fixings holes of a minimum dia. of 6.5 mm on each side. Each urinal shall have an integral flushing box rim of suitable type and inlet or supply horn for connecting the flush pipe.

The flushing rim and inlet shall be of the self-draining type. It shall have a weephole at the flushing inlet of the urinal. At the bottom of the urinal, an outlet horn for connecting to an outlet pipe shall be provided. The exterior of the outlet horn shall not be glazed and the surface shall be provided with grooves at right angles to the axis of the outlet to facilitate fixing to the uniform and smooth throughout to ensure efficient flushing. The bottom of pan shall have sufficient slope from the front, towards the outlet such that there is efficient draining of the urinal. The waste fittings shall be chromium plated.

7.6 Wash Basins

(a) Wash basins shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay as approved by the Employer's Representative and conforming to IS.2556

Type	Size
Flat Back	630 x 450 mm
Flat Back	550 x 400 mm

Wash basins shall be of one piece construction, including a combined overflow. All internal angles shall be designed so as to facilitate cleaning. Each shall have a rim sloping inside towards the bowl on all sides except skirting at the back. Basins shall be provided with single or double tap holes as approved. The tap holes shall be square. A suitable tap hole button shall be supplied if one tap hole is not required in installation. Each basin shall have a circular waste hole to which the interior of basin shall drain.

The waste hole shall be either rebated or bevelled internally with diameter of 65 mm at top and a depth of 10 mm to suit a waste plug having 64 mm diameter. Each basin shall be provided with a non-ferrous 32 mm waste fittings. Stud slots to receive the brackets on the underside of the wash basins shall be suitable for a bracket with stud not exceeding 13 mm diameter, 5 mm high and 305 mm from the back of basin to the centre of the stud. The stud slots shall be of depth sufficient to take 5 mm stud. Every basin shall have an integral soap holder recess or recesses which shall fully drain into the bowl.

The position of the chain stay-hole shall not be lower than the overflow slot. A slot type of overflow having an area of not less than 5 sq.cm. shall be provided and shall be so designed as to facilitate cleaning of the overflow. The Employer's Requirements for waste plug, chain and stay shall be the same as given for sinks.

(b) All the waste fittings shall be chromium plated. Bottle trap shall conform to IS. 5434. The chromium plating shall be of service grade No. 2 conforming to IS.1068.

7.7 Sinks

(a) The sinks shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay as approved by the Employer's Representative conforming to IS.2556 (Part V) and shall be of the following sizes:

450 x 300 x 150 mm
600 x 450 x 200 mm

(b) They shall be of one piece construction, including a combined overflow. The floor of the sink shall gently slope towards the outlet. The outlet shall in all cases be suitable for waste fittings having flange of 64 mm diameter and the waste hole shall have a minimum diameter of 65 mm at the bottom to suit the waste fittings. The waste hole shall be either rebated or bevelled having a depth of 10 mm. Each sink shall be provided with a non-ferrous 40 mm dia. waste fitting. The sink shall have overflow of the weir type and the inverts shall be 30 mm below the top edge. Each sink shall be provided with a waste plug, of suitable dia. chain and stay. The plug shall be of rubber or other equally suitable material and shall be water tight when fitted. Plug chains shall be of brass wire chromium plated. It shall have an overall length from the collar to the stay of not less than 300 mm. There shall be a triangular or D shackle at each

end, one of which shall be brazed to the plug and the other securely fixed to the stay. The 150 mm long shank of the waste shall be threaded conforming to the requirements of IS.2556 for sinks only. The waste fittings and plug fittings shall be chromium plated. The chromium plating shall be of service grade No.2 conforming to IS.1068.

7.8 Flushing Cisterns

The flushing cisterns shall be automatic or manually operated, high level or low level, as approved by the Employer's Representative. For water closets and urinals high level cistern is intended to operate with minimum height of 125 cm and a low level cistern a maximum height of 30 cm between the top of the pan and the underside of the cistern. They shall be of cast iron, glazed earthenware, or pressed steel complying iron, glazed requirement of IS.774. Automatic flushing cistern for urinals shall conform to IS.2326.

7.9 Un plasticised PVC pipes and fittings:

Un plasticised polyvinyl Chloride Pipe for Soil and Waste Discharge System for Inside and Outside Buildings Including Ventilation and Rain Water System IS 13592 and IS 14735 Specification
UPVC Injection Moulded Fittings for Soil and Waste Discharge.

Un plasticised polyvinyl chloride pipes, fittings and specials shall be to BS 3505 for portable water and BS 4346: Part 1for fitting.

The pipe shall be of the spigot and socket type with approved gasket type flexible joint. The rubber gasket shall be to BS 2494, Class C.

IS 7634 Plastic pipe selection, handling storage and installation for portable water supply.
Where PVC pipes, fittings and specifications are to be connected to cast iron, stainless steel or steel pipes, all metallic pipes, Viking Johnson type flange adopted or stepped coupling shall be used.

7.10 Stoneware pipes and fittings

All pipes with spigot and socket ends shall conform to IS.651/3006 and shall be of grade `A'. These shall be sound, free from visible defects such as fine cracks or hair cracks. The glaze of the pipes shall be free from crazing. The pipes shall give a sharp clear note when struck with a light hammer.

The following information shall be clearly marked on each pipe and fitting:

(a) Internal diameter;
(b) Grade;
(c) Date of manufacture;
(d) Name of manufacturer or his registered trade-mark or both.

All pipes and fittings shall have ISI mark.

Jointing of GSW pipes and fittings shall be done as per the requirements of the following Employer's Requirements and the relevant BIS. After jointing, extraneous material if any, shall be removed from the inside of the pipes and fittings and the newly made joints shall be thoroughly cured. In case, rubber sealing rings are used for jointing, these shall conform to IS : 5382.

7.10.1 Spigot and Socket Joint (Cement Joint)

The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. In each joint, spun yarn soaked in neat cement slurry or tarred gasket shall be passed around the joint and inserted in it by means of a caulking tool. More skeins of yarn or gasket shall be added if necessary and shall be well caulked. Yarn or gasket so rammed shall not occupy more than one- fourth of the depth or socket.
Cement mortar (1:1) shall be slightly moistened and carefully inserted by hand into the remaining space of the joint after caulking of yarn or gasket. The mortar shall than be caulked into the joint with a caulking tool. More cement mortar shall be added until the space of joint has been completely filled with tightly caulked mortar. The joint shall then be finished of neatly outside the socket at an angle of 45 degrees.

The cement mortar joints shall be cured at least for seven days before testing.

The approximate quantity of cement required for each joint for certain common sizes of pipes are given below for guidance:

Nominal diameter of pipe (mm)	**Cement (kg)**
150	1.5
200	2.0
250	2.5
300	3.25
350	4.5
400	5.5
450	6.5

7.10.2 Spigot and Socket Joint (Bituminous Joint)

The material for jointing shall consist of composition of asphalt and sand in the ratio of 1:7. Asphalt and sand shall be boiled together and filled into the socket in a molten state with the aid of special moulds.

7.10.3 Spigot and Socket Joint (Rubber Ring Joint)

The pipe with the rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previously laid pipe by means of uniformly applied pressure with the aid of a jack or similar appliance. The rubber rings conforming to IS : 5382 shall be used, and the manufacturer's instructions shall be deemed to form a part of this Employer's Requirements. The rubber rings shall be

lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

7.10.4 Cleaning of Pipes

As soon as a stretch of GSW pipes has been laid complete from machine hole to machine hole or for a length
as approved by the Employer's Representative, the Contractor shall run through the pipes both backward and forward a double disc or solid or closed cylinder 50 mm less in diameter than the internal diameter of pipes. The open end of an incomplete stretch of pipeline shall be securely closed as approved by the Employer's Representative to prevent entry of mud or silt etc.

If as a result of the removal of any obstruction the Employer's Representative considers that damages may have been caused to the pipe lines, he shall be entitled to order the length to be tested immediately. Should such test prove unsatisfactory the Contractor shall repair the pipeline and carry out such further tests as are required by the Employer's Representative.
It shall also be ascertained by the Contractor that each length from machine hole to machine hole or the length as approved by the Employer's Representative is absolutely clear and without any obstruction by means of visual examination of the interior of the pipeline suitably illuminated by projected sunlight or otherwise.

After laying and jointing of GSW pipes is completed the pipe line shall be tested as per the following Employer's Requirements and as approved by the Employer's Representative. All equipment for testing at work site shall be supplied and erected by the Contractor. Water for testing of pipeline shall be arranged by him. Damage during testing shall be the Contractor's responsibility and shall be rectified by him to the full satisfaction of the Employer's Representative. Water used for test shall be removed from pipes and not released to the excavated trenches.

After the joints have thoroughly set and have been checked by the Employer's Representative and before backfilling the trenches, the entire section of the sewer or storm water drain shall be proved by the Contractor to be water tight. Before commencing the hydraulic test, the pipelines shall be filled with water and maintained full for 24 hours by adding water, if necessary, under a head of 0.6 m of water. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water.

A knuckle bend shall be temporarily jointed at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head; or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation. The pipeline shall be subjected to a test pressure of at least 2.5 m head of water at the highest point of the section under test. The tolerance of two litres per centimeter of diameter per kilometer may be allowed during a period of 10 minutes. Any leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work should be removed and made good.

If any damage is caused to the pipeline during the execution of work or while cleaning/testing the pipeline as specified. The Contractor shall be held responsible for the same and shall replace the damaged pipeline and re-test the same to the full satisfaction of the Employer's Representative.

Water for testing of pipeline shall be arranged by the Contractor.

7.11 Stop Cock and Bib Cock

A bibcock (bibtap) is a draw off tap with a horizontal inlet and free outlet and stopcock (stop tap) is a valve with a suitable means of connections for insertion in a pipe line for controlling or stopping the flow. They shall be of specified size and shall be of the screw down type. The closing device should work by means of a disc carrying a renewable non-metallic washer, which shuts against water pressure on a seating at right angles to the axis of the threaded spindle which operates it. The handle shall be either crutch or butterfly type securely fixed to the spindle. The cocks shall open in anti-clockwise direction. When the bib cocks and stop cocks are required to be chromium plated, the chromium plating shall be of service Grade No. 2 conforming to IS.1068. in finish and appearance, the plated articles shall be free from plating defects such as blisters, pits, roughness and shall not be stained or discoloured.

These fittings shall be of brass heavy class, chromium plated (C.P) and of approved manufacture and pattern with screwed of flanged ends as specified. The fittings shall in all respects comply with the requirements of IS.781. The standard size of brass fittings shall be designated by the nominal bore of the pipe to which the fittings are attached. A sample of each kind of fitting shall be approved by the Employer's Representative and all supplies made according to the approved samples.

All cast fittings shall be sound and free from laps, blow holes and fittings, both internal and external surfaces shall be clean, smooth and free from sand etc. Burning, plugging stopping or patching of the casting shall not be permitted. The bodies, bonnets, spindles and other parts shall be truly machined and when assembled the parts shall be axial, parallel and cylindrical with surfaces smoothly finished. The area of the waterway of the fittings shall not be less than the area of the nominal bore.

The fittings shall be fully examined and cleared of all foreign matter before being fixed. The fittings shall be fitted in the pipe line in a workman like manner. The joints between fittings and pipes shall be made leak- proof. The joints and fittings shall be leak proof when subjected to a pressure test approved by the Employer's Representative and the defective fittings and joints shall be replaced or redone.

7.12 Soak Pit

Soak pit shall be constructed at the location specified by the Employer's Representative. Earthwork excavation shall be carried out to the exact dimensions. Brick masonry lining with open joints shall be constructed in the pit upto 150 mm below the outlet pipeline. Brick masonry in cement mortar 1:6 shall be constructed above this level upto ground. Well burnt brick aggregates of nominal size 40 mm to 80 mm and coarse sand shall be filled within the chamber. Construction of pit lining and filling of the brick ballast shall progress simultaneously.

7.13 Machine holes

7.13.1 Location

Machine holes shall be constructed at places approved by the Employer's Representative.

7.13.2 Excavation

Excavation, shoring, dewatering etc. for the pits of machine holes, laying of pipes and fittings/specials shall be done in accordance with Employer's Requirements described elsewhere in the document.

7.13.3 Bed Concrete

The bed concrete for machine holes shall be done in accordance with Employer's Requirements described elsewhere in the document.

7.13.4 Bricks

Bricks used for construction of machine holes shall conform to the relevant Indian Standards. They shall be Wire cut bricks/ Table moulded type, sound, hard, homogeneous in texture, well burnt in kiln without being vitrified, deep red, cherry or copper coloured, of regular shape and size and shall have sharp and square and parallel faces. The bricks shall be free from pores, chips, flaws or humps of any kind. Bricks containing ungrounded particles and/or which absorb water more than 1/6th of their weight when soaked in water for twenty-four hours shall be rejected. Over burnt or under burnt bricks shall be liable to rejection. The bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 50 kg/sq.cm. unless otherwise noted in drawings. The class and quality requirements of bricks shall be as laid down in IS : 1077.

The size of the brick shall be 23.0 x 11.5 x 7.5 cm. unless otherwise specified; but tolerance upto ± 3 mm in each direction shall be permitted. Only full size brick shall be used for masonry work. Brick bats shall be used only with the permission of Employer's Representative to make up required wall length or for bonding. Sample bricks shall be submitted to the Employer's Representative for approval and bricks supplied shall conform to approved samples. If required by the Employer's Representative, brick sample shall be tested as per IS : 3495 by Contractor. Bricks rejected by the Employer's Representative shall be removed from the Site within 24 hours.

7.13.5 Cement Mortar

Mortar for brick masonry shall be prepared as per IS : 2250. Machine holes shall be constructed in brick masonry with cement mortar (1:2) unless otherwise specified. Guage boxes for sand shall be of such dimensions that one bag containing 50 kg. of cement forms one unit. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be as approved by the Employer's Representative. If required by the Employer's Representative sand shall be thoroughly washed till it is free of any contamination.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry conditions. Water shall then be added and mixing continued to give a uniform mix of required consistency. Cement mortar shall be used within 25 minutes of mixing. Mortar left unused in the specified period shall be rejected.

The Contractor shall arrange for tests on mortar samples if so required by Employer's Representative. Retempering of mortar shall not be permitted.

7.13.6 Brick Masonry

All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. Brick work 230 mm thick and over shall be laid in English Bond unless otherwise specified. 115 mm thick brick work shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Bricks shall be laid with frogs uppermost.

All brickwork shall be plumb and square unless otherwise shown on drawing and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. For walls of thickness greater than 230 mm both faces shall be kept in vertical planes unless otherwise specified.

All interconnected brickwork shall be carried out at nearly one level (so that there is uniform distribution of pressure on the supporting structure) and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45 degrees. But in no case the level difference between adjoining walls shall exceed 1.25 M. Workmanship shall conform to IS : 2212.

Brick shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 12 mm by raking tools daily during the progress of work when the mortar is still green, so as to provide a proper key for the plastering to be done. When plastering is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top. If mortar in the lower courses has begun to set, the joints shall be raked out to a depth of 12 mm before another course is laid.

7.13.7 Cement Plaster

All joints in masonry shall be raked to a depth of 12 mm with hooked tool made for the purpose when the mortar is still green and in any case within 48 hours of its laying. The surface to be rendered shall be washed with fresh clean water free from all dirt, loose material, grease etc. and thoroughly wetted for 6 hours before plastering work is commenced. Concrete surfaces to be rendered will however be kept dry. The wall should not be too wet but only damp at the time of plastering. The damping shall be uniform to get uniform bond between the plaster and the wall.

The proportion of the cement mortar shall be as approved on relevant drawings. Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shall be as per relevant I.S. The mortar thus mixed shall be used immediately and in no case shall the mortar be allowed to remain for more than 25 minutes after mixing with water.

Curing of plaster shall be started as soon as the applied plaster has hardened enough so as not to be damaged. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days.

Plastering shall be done on both faces of brick masonry in cement mortar (1:2) and 20 mm thick unless otherwise specified.

Plastering work shall be carried out in two layers, the first layer being 14 mm thick and the second layer being 6 mm thick. The first layer shall be dashed against the prepared surface with a trowel to obtain an even surface. The second layer shall then be applied and finished leaving an even and uniform surface, trowel finished unless otherwise approved by the Employer's Representative.

7.13.8 Cement Concrete Channel

The channel for the machine hole shall be constructed in cement concrete of M15 grade. Both sides of the channel shall be taken up to the level of the crown of the outgoing sewer. They shall be benched up in concrete and rendered in cement mortar (1:1) of 20 mm thickness and formed to a slope of 1 in 12 towards the channel.

7.13.9 Pipe Entering or Leaving Machine hole

Whenever a pipe enters or leaves a machine hole, bricks on edge must be cut to a proper form and laid around the upper end of the pipe so as to form an arch. All around the pipes, there shall be a joint of cement mortar (1:2) 13 mm thick between it and the bricks.

7.13.10 PVC encapsulated Rungs

Rungs shall meet the dimensions as specified in IS : 5455. Material shall be in Fe415 or Fe500 plastic encapsulated. The steps shall be clean, well cast and they shall be free from air and sand holes, cold shuts and warpings. The portion of the step which projects from the wall of the machine hole shall have adequate non-slip grip.

Where the depth of invert of machine hole exceeds 800 mm, the steps of approved pattern shall be fixed in the brick work or RCC at the interval of 300 mm vertically and staggered at 380 mm horizontally centre to centre. In case of pipe diameter greater than 600 mm, box type steps shall be provided at 300 mm vertically in channel of machine hole.

7.13.11 Frame and Covers

Frame and covers for machine holes shall be of required type and dimensions as per the relevant drawings prepared by the Contractor. Following information shall be clearly marked on each cover.
Year of manufacture,
Identification mark of the purchaser,
SEWERS/SWD,
Arrow showing direction of flow

7.13.11.1 Cast Iron Frame and Cover

The cast iron frame and cover shall be of grey cast iron as per IS : 1726. The general requirements for casting and coating of CI frame and cover shall be as specified for CI steps in Clause 7.15.10. The covers shall have a raised chequered design to provide an adequate non-slip grip. The rise of the chequer shall be not less than 4 mm. The locking device for the cover shall be provided as approved

by the Employer's Representative. The CI covers for the load test shall be selected at one for every lot of fifty or part thereof for each type and size manufactured and as approved by the Employer's Representative. The frame shall be fixed in cement concrete of M15 grade all round and finished with neat cement. The machine hole frame shall have 560 mm diameter clear opening and shall weigh not less than 208 kg. including cover. In case of rectangular CI frame and cover of 900 mm x 600 mm clear opening, the total weight shall not be less than 275 kg. In case of scraper machine hole the frame shall have clear opening of 1200 mm x 900 mm and shall weigh not less than 900 kg including cover. The machine hole cover and frame shall be painted with three coats of anti-corrosive paint after fixing in position.

7.13.11.2 Fibre Reinforced Concrete Frame and Cover

Fibre reinforced concrete frame and cover shall be capable of withstanding load of 35 tonnes. The frame shall be fixed in cement concrete of M15 grade all around and finished with neat cement. The fibre reinforced frame shall have clear opening of 560 mm diameter and weighing 102 kg. The cover shall have a minimum thickness of 100 mm and weighing 78 kg. The fibres shall constitute 1% of the weight of the concrete in the form of 50 mm to 100 mm long high tensile steel wires. For the cover, MS sheet lapping of 18 gauge shall be provided to avoid damage to the edges. Similarly for frame, MS angle/flat shall be provided along the edge. Both MS sheet and angle shall be painted with black bituminous paint. The cover should have suitable lifting arrangement. The fibre reinforced frame and cover shall be manufactured as approved.

7.13.11.3 Reinforced Cement Concrete Frame and Cover

Reinforced cement concrete frame and cover for machine holes shall be of required dimensions and shape as shown on the drawing prepared by the Contractor. The frame and cover shall be cast in cement concrete of M25 grade. Minimum cover to the reinforcement shall be 40 mm. The edges of frame and covers shall be provided with mild steel angles to avoid damages to the corners. These angles shall be painted with black bituminous paint. The covers should have suitable lifting arrangement.

7.13.12 Drop Machine hole

When a sewer connects a main sewer, and where the difference in level between water line (peak flow levels) of main line and the invert level of branch lines is more than 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or impractical to arrange the connection within 600 mm, a drop connection shall be provided for which a machine hole shall be constructed as per relevant drawing, incorporating a vertical drop pipe from the higher sewer to the lower one. This pipe shall be provided outside the shaft and encased in concrete. A continuation of the branch sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with a half blank flange. The diameter of the back drop should be at least as large as that of the incoming pipe. The drop pipe should terminate at its lower end with a plain or duck-foot bend turned so as to discharge its flow at 45 degrees or less to the direction of the flow in the main sewer. The pipe unless of cast iron should be surrounded with 150 mm thick concrete.

In the case of sewers over 450 mm in diameter the drop in level may be accomplished by one of the following approved methods:

(a) A cascade;

(b) A ramp;
(c) By drops in previous machine holes.

7.13.13 RCC Machine hole

M30 grade of concrete used for construction of RCC machine hole shall have minimum cement content of 400 kg/cum of concrete. Minimum cover to the reinforcement shall be 50 mm.

7.13.14 Vent Shafts

7.13.14.1 General

Vent shafts shall be erected at such places as approved by the Employer's Representative.

7.13.14.2 Mild Steel Vent Shaft

Mild steel vent shaft shall be of 150 mm diameter and 12.17 m height from ground level with C.I. ornamental cap. This shall be fixed firmly and encased in cement concrete of M15 grade as shown on relevant drawing with necessary mild steel bolts, plates etc. for foundation. The vent shaft shall be painted with one coat of silver paint over one coat of red lead oxide paint. The vent shaft shall be connected to machine hole by 150 mm diameter glazed stoneware pipe encased by M10 concrete of 150 mm thickness all around as approved by the Employer's Representative.

7.13.14.3 RCC Vent Shaft

Reinforced cement concrete vent shaft shall be of M30 grade concrete, 200 mm diameter at bottom and tapered to 100 mm diameter at top (both inside clear openings) and 6 m height from ground level. The vent shaft shall be embedded in concrete of M10 grade and anchored by 2 nos. of 16 mm diameter and 600 mm long MS bars. The vent shaft shall be connected to machine hole as specified in (b) above through a brick masonry flue chamber.

7.13.15 Miscellaneous

If any damage is caused to the other services such as water supply pipeline, sewer, cable, etc. during the construction of machine holes and erection of vent shafts, the Contractor shall be held responsible for the same and shall replace the damaged services to the full satisfaction of the Employer's Representative.

The interior of machine holes shall be cleared of all debris after construction and before testing the same for water tightness by the Contractor.

7.14 Measurement for Pipes

AC, Cast iron and S.W. drainage pipes shall be measured along the centrelines of pipes including all fittings such as junctions, plug bends etc., for which no separate payment shall be made.

GI pipes with fittings completely fixed in position shall be measured and paid for the finished centreline lengths, including all fittings such as tees, bends, couplings etc., for which no separate payment shall be made.

In measuring the lengths of sewer pipes laid, length between faces of machine holes shall be considered. Inspection chambers shall only be measured omitting lengths of channels between inside faces of walls of machine holes of chambers.

End of Chapter-7

CHAPTER 8

GENERAL CIVIL WORKS

CHAPTER 8

GENERAL CIVIL WORKS

8.1 Applicable Codes and Specifications

The following codes and standards are included in this Chapter.

IS:110 - Ready mixed paint, brushing, grey filler, for enamels for use over primers

IS:269 - Specification for Ordinary Portland cement

IS:280 - Specification for mild steel wire for general engineering purposes

IS:287 - Recommendations for maximum permissible moisture content of timber used for different purposes

IS: 304 - High Tensile Brass Ingots and Castings.

IS:337 - Varnish, finishing interior

IS:348 - French polish

IS:383 - Specification for coarse and fine aggregates from natural sources for concrete

IS:412 - Expanded metal steel sheets for general purposes

IS:419 - Specification for putty for use on window frames

IS:428 - Distemper, oil emulsion, colour as required

IS:459 - Specification for unreinforced corrugated and semi-corrugated asbestos cement sheets

IS:702 - Specification for industrial bitumen

IS:710 - Specification for marine plywood

IS:712 - Specification for building limes

IS:730 - Specification for hook bolts for corrugated sheet roofing

IS:733 - Wrought aluminium and aluminium alloys, bars, rods and sections for general engineering purposes

IS:777 - Specification for glazed earthenware tiles

IS:1003 - Specification for timber panelled and glazed shutters (Parts 1 & 2)

IS:1038 - Specification for steel doors, windows and ventilators

IS:1077 - Specification for common burnt clay building bricks

IS:1081 - Code of practice for fixing and glazing of metal (steel & aluminium) doors, windows and ventilators

IS:1124	-	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones
IS:1237	-	Specification for cement concrete flooring tiles
IS:1322	-	Bitumen felts for water proofing and damp proofing
IS:1346	-	Code of practice for water proofing of roofs with bitumen felts
IS:1361	-	Specification for steel windows for industrial buildings
IS:1397	-	Specification for kraft paper
IS:1443	-	Code of practice for laying and finishing of cement concrete flooring tiles
IS:1477	-	Code of practice for painting of ferrous metals in buildings (Parts 1 & 2)
IS:1542	-	Specification for sand for plaster
IS:1580	-	Specification for bituminous compounds for water-proofing and caulking purposes
IS:1597	-	Code of practice for construction of stone masonry: Part 1 Rubble stone masonry
IS:1659	-	Specification for block boards
IS:1661	-	Code of practice for application of cement and cement-lime plaster finishes
IS:1834	-	Specification for hot applied sealing compound for joint in concrete
IS:1838	-	Specification for preformed fillers for expansion joint in concrete pavements and structures (non extruding and resilient type): Part 1 Bitumen impregnated fibre
IS:1948	-	Specification for aluminium doors, windows and ventilators
IS:1949	-	Specification for aluminium windows for industrial buildings
IS:2074	-	Ready mixed paint, air drying, red oxide- zinc chrome, priming
IS:2098	-	Asbestos cement building boards
IS:2114	-	Code of practice for laying in-situ terrazzo floor finish
IS:2116	-	Specification for sand for masonry mortars
IS:2185	-	Specification for concrete masonry units (Parts 1,2 & 3)
IS:2202	-	Specification for wooden flush door shutters (Solid core type) : Parts 1 & 2
IS:2212	-	Code of practice for brickwork
IS:2250	-	Code of practice for preparation and use of masonry mortars
IS:2338	-	Code of practice for finishing of wood and wood-based materials (Parts 1 & 2)

IS:2339	-	Aluminium paint for general purposes, in dual container
IS:2395	-	Code of practice for painting concrete, masonry and plaster surfaces (Parts 1 & 2)
IS:2402	-	Code of practice for external rendered finishes
IS:2571	-	Code of practice for laying in-situ cement concrete flooring
IS:2645	-	Specification of integral cement waterproofing compounds
IS:2690	-	Specification for burnt clay flat terracing tiles: Part 1 Machine made
IS:2691	-	Specification for burnt clay facing bricks
IS:2750	-	Specification for steel scaffoldings
IS:2835	-	Flat transparent sheet glass
IS:2932	-	Specification for enamel, synthetic, exterior type (a) undercoating, (b) finishing
IS:3007	-	Code of practice for laying of asbestos cement sheets - corrugated and (Part 1 & 2) semi-corrugated sheets
IS:3036	-	Code of practice for laying lime concrete for a water-proofed roof finish
IS:3067	-	Code of practice of general design details and preparatory work for damp-proofing and water- proofing of buildings
IS:3068	-	Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete
IS:3384	-	Specification for bitumen primer for use in water-proofing and damp-proofing
IS:3461	-	Specification for PVC-asbestos floor tiles
IS:3462	-	Specification for unpacked flexible PVC flooring
IS:3495	-	Method of test for burnt clay building bricks: Part 1 to 4
IS:3536	-	Specification for ready mixed paint, brushing, wood primer, pink
IS:3564	-	Specification for door closers (hydraulically regulated)
IS: 3614 (Part – 1)	-	Specification for fire checks doors: Part –I Plate metal covered and rolling type
IS: 3614 (Part – 2)	-	Specification for metallic and non-metallic fire check doors: Part-2 Resistance test and performance criteria
IS:3696	-	Safety code of scaffolds and ladders (Parts 1 & 2)

IS:4020	-	Methods of test for wooden flush door: Type test
IS:4021	-	Specification for timber door, window and ventilator frames
IS:4351	-	Specification for steel door frames
IS:4443	-	Code of practice for use of resin type chemical resistant mortars
IS:4457	-	Specification for ceramic unglazed vitreous acid resisting tile
IS:4631	-	Code of practice for laying epoxy resin floor toppings
IS:4832	-	Specification for chemical resistant mortars (Part II)
IS:4860	-	Specification for acid resistant bricks
IS:4948	-	Specification for welded steel wire fabric for general use
IS:5318	-	Code of practice for laying of flexible PVC sheet and tile flooring
IS:5410	-	Cement paint, colour as required
IS:5411	-	Specification for plastic emulsion paint (Parts 1 & 2)
IS:5437	-	Wired and figured glass
IS:5491	-	Code of practice for laying of in-situ granolithic concrete floor topping
IS:6041	-	Code of practice construction of autoclaved cellular concrete block masonry
IS:6042	-	Code of practice for construction of light weight concrete block masonry
IS:6248	-	Specification for metal rolling shutters and rolling grilles
IS:7193	-	Specification for glass fibre base coal tar pitch and bitumen felts
IS:7452	-	Specification for hot rolled steel sections for doors, windows and ventilators
IS:8042	-	Specification for white Portland cement
IS:8543	-	Methods of testing plastics
IS:8869	-	Specification for washers for corrugated sheet roofing
IS: 9197	-	Specification for epoxy resin, hardeners and epoxy resin composites for floor topping
IS:9862	-	Specification for ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and chlorine resisting
IS:12200	-	Code of practice for provision of waterstops at transverse contraction joints in masonry and concrete dams

BS: 476 (Part – 20)	-	Methods for determination of the fire resistance of elements of construction (General Principles)
BS: 476 (Part – 21)	-	Methods for determination of the fire resistance of load bearing elements of construction
BS: 476 (Part – 22)	-	Methods for determination of the fire resistance of non-load bearing elements of construction
Part – IV	-	National Building code of India (Fire Protection)

8.2 Brickwork

8.2.1 Materials

Bricks used in the works shall conform to the requirements laid down in IS: 1077. The class of the bricks shall be as specifically indicated in the respective items of work.

The nominal size of the modular brick shall be 200 mm x 100 mm x 100 mm with the permissible tolerances over the actual size of 190 mm x 90 mm x 90 mm as per IS: 1077. The nominal thickness of one brick and half brick walls using modular bricks shall be considered as 200 mm and 100 mm respectively. In the event of use of traditional bricks of nominal size 230 mm x 115 mm x 75 mm with a tolerance of up to 3 mm in each dimension, one brick and a half brick walls shall be considered as 230 mm and 115 mm respectively.

Bricks shall be sound, hard, homogenous in texture, well burnt in kiln without being vitrified, hand/machine moulded, deep red, cherry or copper coloured, of regular shape and size & shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. Hand moulded bricks shall be moulded with a frog and those made by extrusion process may not be provided with a frog. Bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 5N/sq.mm unless otherwise specified in the items of work.

The average water absorption shall not be more than 20 percent by weight upto class 12.5 and 15 percent by weight for higher classes. Bricks which do not conform to this requirement shall be rejected. Over or under burnt bricks are not acceptable for use in the works.

Sample bricks shall be submitted to the Engineer for approval and bricks supplied shall conform to approved samples. If demanded by Engineer, brick samples shall be got tested as per IS: 3495 by Contractor. Bricks rejected by Engineer shall be removed from the site of works within 24 hours.

Mortar for brick masonry shall consist of cement and sand and shall be prepared as per IS: 2250. Mix shall be in the proportion of 1:5 for brickwork of thickness one brick or above and 1:4 for brickwork of thickness half brick or below, unless otherwise specified in the respective items of work. Sand for masonry mortar shall conform to IS: 2116. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand

shall be approved by Engineer. If so directed by the Engineer, sand shall be screened and washed till it satisfies the limits of deleterious materials.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Mixing shall be done thoroughly in a mechanical mixer, unless the Engineer specifically permits hand mixing. The mortar thus mixed shall be used as soon as possible, preferably within 30 minutes from the time water is added to cement. Incase, the mortar has stiffened due to evaporation of water, this may be re-tempered by adding water as required to restore consistency, but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and shall be removed forthwith from the site. Droppings of mortar shall not be re-used under any circumstances.

The Contractor shall arrange for test on mortar samples if so directed by the Engineer.

8.2.2 Workmanship

Workmanship of brick work shall conform to IS: 2212. All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work. Brick work 200mm/230mm thick and over shall be laid in English Bond unless otherwise specified. 100mm/115mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightly pressed into the mortar and shoved into its final position so as to embed the brick fully in the mortar. Only full-size bricks shall be used for the works and cut bricks utilised only to make up required wall length or for bonding. Bricks shall be laid with frogs uppermost.

All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. In case of one brick thick or half brick thick wall, atleast one face should be kept smooth and plane, even if the other is slightly rough due to variation in size of bricks. For walls of thickness greater than one brick both faces shall be kept smooth and plane. All interconnected brickwork shall be carried out at nearly one level so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45 deg. But in no case the level difference between adjoining walls shall exceed one metre. Brick work shall not be raised more than one metre per day.

Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10mm/15mm by raking tools during the progress of work when the mortar is still green, so as to provide a proper key for the plastering/ pointing respectively to be done later. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top.

During inclement weather conditions, newly built brick masonry works shall be protected by tarpaulin or other suitable covering to prevent mortar being washed away by rain.

Brickwork shall be kept constantly moist on all the faces for at least seven days after 24 hrs of laying. The arrangement for curing shall be got approved from the Engineer.

Double scaffolding having two sets of vertical supports shall be provided to facilitate execution of the masonry works. The scaffolding shall be designed adequately considering all the dead, live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS:2750 and IS:3696 (Part I). Scaffolding shall be properly maintained during the entire period of construction. Single scaffolding shall not be used on important works and will be permitted only in certain cases as decided by the Engineer. Where single scaffolding is adopted, only minimum number of holes, by omitting a header shall be left in the masonry for supporting horizontal scaffolding poles. All holes in the masonry shall be carefully made good before plastering/pointing.

In the event of usage of traditional bricks of size 230 mm x115mm x75mm, the courses at the top of the plinth and sills as well as at the top of the wall just below the roof/floor slabs and at the top of the parapet shall be laid with bricks on edge.

All brickwork shall be built tightly against columns, floor slabs or other structural members.

To mitigate the risk of developing cracks in the brick masonry, the following measures shall be implemented.

For resting RCC slabs, the bearing surface of the masonry wall shall be finished on top with 12 mm thick cement mortar 1:3 and provided with two layers of Kraft paper Grade 1 as per IS:1397 or two layers of 50 micron thick polyethylene sheets.

RCC/steel beams resting on a masonry wall shall be provided with reinforced concrete bed blocks of 50 mm thickness, projecting 50 mm on either side of the beam, duly finished on top with two layers of Kraft paper Grade 1 as per IS:1397 or two layers of 50 micron thick polyethylene sheets.

Steel wire fabric shall be provided at the junction of brick masonry and concrete before taking up plastering work.

Bricks for partition walls shall be stacked adjacent to the structural member to pre-deflect the structural member before the wall is taken up for execution. Further, the topmost course of half or full brick walls abutting against either a de-shuttered slab or beam shall be built only after any proposed masonry wall above the structural member is executed to cater for the deflection of the structural element.

Reinforced cement concrete transoms and mullions of dimensions as indicated in the construction Drawings are generally required to be provided in the half brick partition walls.

Where the drawings indicate that structural steel sections are to be encased in brickwork, the brick masonry shall be built closely against the steel section, ensuring a minimum of 20 mm thick cement-sand mortar 1:4 over all the steel surfaces. Steel sections partly embedded in brickwork shall be provided with bituminous protective coating to the surfaces at the point of entry into the brick masonry.

Contractor shall note that the unit rates quoted for the masonry work shall be deemed to include for the installation of miscellaneous inserts such as pipe sleeves, bolts, steel sections with anchors etc. and provide pockets, leaving openings, cutting chases etc. in accordance with the

construction drawings. Miscellaneous inserts shall be either supplied free by the Employer or to be furnished by the Contractor. Any of the miscellaneous inserts which are required to be fabricated and supplied by the Contractor and cement concrete to be provided in the pockets for holdfasts of door/window frames etc. shall however, be measured and paid for separately under the respective items of work.

Facing bricks of the type specified conforming to IS: 2691 shall be laid in the positions indicated on the drawings and all facing brickwork shall be well bonded to the backing bricks/RCC surfaces. The level of execution of the facing brick work shall at any time be lower by at least 600 mm below the level of the backing brickwork.

Facing bricks shall be laid over 10 mm thick backing of cement mortar. The mortar mix, thickness of joint and the type of pointing to be carried out shall be as specified in the item of works. The pattern of laying the bricks shall be as specifically indicated in the drawings.

For facing brickwork, double scaffolding shall be used.

Faced works shall be kept clean and free from damage, discoloration etc., at all times.

8.2.3 Measurement

Measurement shall be in cu. m correct to two places of decimal for brickwork of thickness one brick i.e. 200 mm/230 mm and above. Measurement shall be in sq. m correct to two places decimal for facing brickwork and brickwork of thickness half brick i.e. 100mm/115mm and below. Measurement shall be for the quantities as actually executed duly deducting for openings, lintels, transoms / mullions etc. All concrete works shall be measured and paid for separately under the respective items of work.

8.3 Uncoursed Random Rubble Masonry in Foundation, Plinth and Superstructure

8.3.1 Materials

Stones for the works shall be of the specified variety which is hard, durable, fine grained and uniform in colour (for superstructure work) free from veins, flaws and other defects. Quality and work shall conform to the requirements specified in IS:1597 (Part-I). The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS: 1124. The Contractor shall supply sample stones to the Engineer for approval. Stones shall be laid with its grains horizontal so that the load transmitted is always perpendicular to the natural bed.

Cement-sand mortar for stone masonry works shall be in the proportion of 1:6. Materials and preparation of mortar shall be as specified in clause 8.2.1.

8.3.2 Workmanship

For all works below ground level, the masonry shall be random rubble uncoursed with ordinary quarry-dressed stones for the hearting and selected quarry-dressed stones for the facing.

For all works above ground level and in superstructure, the masonry shall be random rubble uncoursed, well bonded, faced with hammer-dressed stones with squared quoins at corners. The bushings on the face shall not be more than 40 mm on an exposed face and on the face to be plastered it shall not project by more than 12 mm nor shall it have depressions more than 10 mm from the average wall surface.

Face stones shall extend back sufficiently and bond well with the masonry. The depth of stone from the face of the wall inwards shall not be less than the height or breadth at the face. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three-fourths the thickness of wall nor less than 150 mm. The height of stone may be up to a maximum of 300 mm. Face stones or hearting stones shall not be less than 150 mm in any direction.

Chips and spalls shall be used wherever necessary to avoid thick mortar joints and to ensure that no hollow spaces are left in the masonry. The use of chips and spalls in the hearting shall not exceed 20 percent of the quantity of stone masonry. Spalls and chips shall not be used on the face of the wall and below hearting stones to bring them to the level of face stones.

The maximum thickness of joints shall not exceed 20 mm. All joints shall be completely filled with mortar. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool during the progress of the work while the mortar is still green.

Through or bond stones shall be provided in walls up to 600 mm thick and in case of walls above 600 mm thickness, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided in a line from face to back. In case of highly absorbent types of stones (porous limestone and sandstone, etc.), the bond stone shall extend about two-thirds into the wall, and a set of two or more bond stones overlapping each other by at least 150 mm shall be provided. Each bond stone or a set of bond stones shall be provided for every 0.5 sq. m of wall surface.

All stones shall be sufficiently wetted before laying to prevent absorption of water from the mortar. All connected walls in a structure shall be normally raised uniformly and regularly. However, if any part of the masonry is required to be left behind, the wall shall be raked back (and not saw toothed) at an angle not exceeding 45 degrees. Masonry work shall not be raised by more than one metre per day.

Green work shall be protected from rain by a suitable covering. Masonry work shall be kept constantly moist on all the faces for a minimum period of seven days for proper curing of the joints.

Type of scaffolding to be used shall be as specified in clause 8.2.2.

8.3.3 Measurement

Measurement shall be in cu. m correct to two places of decimal. The quantities measured and paid for, shall be those as actually executed after making necessary deductions for openings, lintels etc.

8.4 Coursed Rubble Masonry (First Sort) for Superstructure

8.4.1 Materials

The Material specification for the work shall be as per clause 8.3.1.

8.4.2 Workmanship

All courses shall be laid truly horizontal and shall be of the same height in any course. The height of course shall not be less than 150 mm and not more than 300 mm. The width of stone shall not be less than its height.

Face stones shall tail into the work for not less than their height and at least 1/3rd the number of stones shall tail into the work for a length not less than twice their height but not more than three-fourths the thickness of the wall whichever is smaller. These should be laid as headers and stretchers alternately to break joints by at least 75 mm.

The face stones shall be squared on all joints and beds; the bed joints being hammer or chisel dressed true and square for at least 80 mm back from the face and the side joints for at least 40 mm. The face of the stone shall be hammer dressed so that the bushing shall not be more than 40 mm on an exposed face and 10 mm on a face to be plastered. No portion of the dressed surface shall show a depth of gap more than 6 mm from a straight edge placed on it. The remaining unexposed portion of the stone shall not project beyond the surface of bed and side joints.

No spalls or pinning's shall be allowed on the face. All bed joints shall be horizontal and side joints shall be vertical and no joints shall be more than 10 mm in thickness. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool, during the progress of the work while the mortar is still green.

Hearting shall consist of flat bedded stones carefully laid on their proper beds and solidly bedded in mortar. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10 percent of the quantity of the stone masonry. Care shall be taken so that no hollow spaces are left anywhere in the masonry.

The requirement regarding through or bond stones shall be as specified in clause 8.3.2 with the further stipulation that these shall be provided at 1.5 m to 1.8m apart clear in every course but staggered at alternate courses.

The quoins which shall be of the same height as the course in which they occur, shall not be less than 450 mm in any direction. Quoin stones shall be laid as stretchers and headers alternately. They shall be laid square on their beds, which shall be rough chisel dressed to a depth of at least 100 mm from the face. These stones shall have minimum uniform chisel drafts of 25mm width at four edges, all the edges being in the same plane.

Type of scaffolding to be used shall be as per Clause 8.2.2.

Requirements of execution of the work and curing shall be as stipulated in clause 8.3.2.

8.4.3 Measurement

Measurement shall be in cu. m correct to two places of decimal. The quantities measured and paid for, shall be those as actually executed after making necessary deductions for openings, lintels etc.

8.5 Concrete Block Masonry

8.5.1 Materials

Masonry units of solid concrete blocks shall conform to the requirements of IS : 2185 (Part 1).

Masonry units of solid light-weight concrete blocks shall conform to the requirements of IS : 2185 (Part 2).

Masonry units of autoclaved cellular concrete blocks shall conform to the requirements of IS:2185 (Part 3).

The height of the concrete masonry units shall not exceed either its length or six times its width.

The nominal dimensions of a concrete block shall be as follows.

Length 400, 500 or 600 mm

Height 100 or 200 mm

Width 100 to 300 mm in 50 mm increments

Half blocks shall be in lengths of 200, 250 or 300mm to correspond to the full length blocks. Actual dimensions shall be 10mm short of the nominal dimensions.

The maximum variation in the length of the units shall not be more than ±5 mm and maximum variation in height or width of the units shall not be more than ± 3mm.

Concrete blocks shall be of solid blocks and shall be sound, free of cracks, chipping or other defects which impair the strength or performance of the construction. Surface texture shall be as specified. The faces of the units shall be flat and rectangular, opposite faces shall be parallel and all arises shall be square. The bedding surfaces shall be at right angles to the faces of the block.

The concrete mix for the solid concrete blocks/light weight concrete blocks shall not be richer than one part of cement to six parts of combined aggregates by volume.

Concrete blocks shall be of approved manufacture, which satisfy the limitations in the values of water absorption, drying shrinkage and moisture movement, as specified for the type of block as per relevant IS code. Contractor shall furnish the test certificates and also supply the samples for the approval of Engineer.

8.5.2 Workmanship

The type of the concrete block, thickness, and grade based on the compressive strength for use in load-bearing and/or non-load-bearing walls shall be as specified. The minimum nominal thickness of non-load-bearing internal walls shall be 100mm. The minimum nominal thickness of external panel walls in framed construction shall be 200 mm.

The workmanship shall generally conform to the requirements of IS: 2572 for concrete block masonry, IS:6042 for light weight concrete block masonry and IS:6041 for autoclaved cellular concrete block masonry works.

From considerations of durability, generally concrete block masonry shall be used in superstructure works above the damp-proof course level.

Concrete blocks shall be embedded with a mortar which is relatively weaker than the mix of the blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works. Preparation of mortar shall be as specified in clause 8.2.1.

The thickness of both horizontal and vertical joints shall be 10mm. The first course shall be laid with greater care, ensuring that it is properly aligned, leveled and plumb since this will facilitate in laying succeeding courses to obtain a straight and truly vertical wall. For the horizontal (bedding) joint, mortar shall be spread over the entire top surface of the block including front and rear shells as well as the webs to a uniform layer of 10mm. For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may be applied either to the unit already placed on the wall or on the edges of the succeeding unit when it is standing vertically and then placing it horizontally, well pressed against the previously laid unit to produce a compacted vertical joint. In case of two cell blocks with slight depression on the vertical sides these shall also be filled up with mortar to secure greater lateral rigidity. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block as the mortar will stiffen and lose its plasticity Mortar while hardening shrinks slightly and thus pulls away from the edges of the block. The mortar shall be pressed against the units with a jointing tool after it has stiffened to effect intimate contact between the mortar and the unit to obtain a weather tight joint. The mortar shall be raked to a depth of 10mm as each course is laid to ensure good bond for the plaster.

As per the design requirements and to effectively control cracks in the masonry, RCC bound beams/studs, joint reinforcement shall be provided at suitable locations. Joint reinforcement shall be fabricated either from mild steel wires conforming to IS:280 or welded wire fabric/high strength deformed basis as per the drawings.

At the intersection of walls, the courses shall be laid up at the same time with a true masonry bond between at least 50% of the concrete blocks. The sequence for the construction of partition walls and treatment at the top of load-bearing walls for the RCC slab shall be as detailed under clause 8.2 for the brick work.

Curing of the mortar joints shall be carried out for atleast 7 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet.

Double scaffolding as per clause 8.2.2 shall be adopted for execution of block masonry work.

Cutting of the units shall be restricted to a minimum. All horizontal and vertical dimensions shall be in respectively, adopting modular co-ordination for walls, opening locations for doors, windows etc.

Concrete blocks shall be stored at site suitably to avoid any contact with moisture from the ground and covered to protect against wetting.

8.5.3 Measurement

Measurement shall be in cu. m. correct up to two places of decimal for walls of thickness 200 mm and above. Measurement shall be in sq.m correct upto two places of decimal for walls of 100 mm/150 mm in thickness. Measurement shall be for the quantities as actually executed duly

deducting for openings and concrete works. Concrete and reinforcement will be measured and paid for separately. The rate quoted shall be for the type of masonry blocks specified in the respective items of work which shall include for the specific sequential operations as stipulated in the construction drawings.

8.6 Damp - Proof Course

8.6.1 Materials and Workmanship

Where specified, all the walls in a building shall be provided with damp-proof course cover plinth to prevent water from rising up the wall. The damp-proof course shall run without a break throughout the length of the wall, even under the door or other openings. Damp-proof course shall consist of 50 mm thick cement concrete of 1:2:4 nominal mix with approved water-proofing compound admixture conforming to IS: 2645 in proportion as directed by the manufacturer. Concrete shall be with 10 mm down graded coarse aggregates.

The surface of brickwork/stone masonry work shall be leveled and prepared before laying the cement concrete. Side shuttering shall be properly fixed to ensure that slurry does not leak through and is also not disturbed during compaction. The upper and side surface shall be made rough to afford key to the masonry above and to the plaster.

Damp-proof course shall be cured properly for atleast seven days after which it shall be allowed to dry for taking up further work.

8.6.2 Measurement

Measurement of damp-proof course shall be in sq.m correct to two places of decimal as actually executed. No separate payment will be made for formwork.

8.7 Miscellaneous Inserts, Bolts etc.

All the miscellaneous inserts such as bolts, pipes, plate embedment etc., shall be accurately installed in the building works at the correct location and levels, all as detailed in the construction drawings. Contractor shall prepare and use templates for this purpose, if so directed by the Engineer. In the event, of any of the inserts are improperly installed, Contractor shall make necessary arrangements to remove and reinstall at the correct locations/levels, all as directed by the Engineer without any extra cost to the Employer.

8.7 .1 Measurement

Miscellaneous inserts, supplied by the Contractor shall be measured and paid for as per the respective items of work.

8.8 Woodwork in Doors, Windows, Ventilators & Partitions

8.8.1 Materials

Timber to be used shall be first class Teak wood as per IS:4021. Timber shall be of the best quality and well seasoned by a suitable process before being planed to the required sizes. The maximum permissible moisture content shall be from 10 to 16 percent for timber 50mm and above in thickness and 8 to 14 percent of timber less than 50mm in thickness for different regions of the country as stipulated in IS:287. Timber shall be close grained, of uniform colour and free

from decay, fungal growth, boxed heart, pitch pockets or streaks on the exposed edges, borer holes, splits and cracks.

Flush door shutters of the solid core type with plywood face panels shall conform to IS: 2202 (Part 1), and those with particle board or hardboard face panels shall conform to IS: 2202 (Part 2).

Transparent sheet glass shall conform to the requirements of IS: 2835. Wired and figured glass shall be as per IS: 5437.

Builder's hardware for fittings and fixtures shall be of the best quality from approved manufacturers.

8.8.2 Workmanship

The workmanship and finish of wood work in doors, windows, ventilators and partitions shall be of a very high order. Contractor shall ensure that work is executed professionally by skilled carpenters for good appearance, efficient and smooth operation of the shutters.

All works shall be executed as per the detailed drawings and/or as directed by the Engineer.

All members of the door, window, and ventilator shall be straight without any warp or bow and shall have smooth well planed faces. The right angle shall be checked from the inside surfaces of the respective members of the frame. Frames shall have mortice and tenon joints which shall be treated with an approved adhesive and provided with metal or wood pins. The vertical members of the door frame shall project 50 mm below the finished floor level. The finished dimension of frames shall be rebated on the solid for keying with the plaster and for receiving the shutters. The depth of rebate for housing the shutter shall be 15 mm. The size of the frames shall be as specified in the respective items of work. The workmanship shall generally conform to the requirements specified in IS:4021.

The face of the frames abutting the masonry or concrete shall be provided with a coat of coal tar.

Three hold fasts using 25 mm x 6 mm mild steel flats 225 mm long with split ends shall be fixed on each side of door and window frames, one at the centre and the other two at 300 mm from the top and bottom of the frame. For window and ventilator frames less than 1 m in height, two hold fasts on each side shall be fixed at quarter points.

Timber panelled shutters for doors, windows and ventilators shall be constructed in the form of framework of stiles and rails with panel insertion. The panels shall be fixed by either providing grooves in the stiles and rails or by beading. Glazing bars shall be as detailed in the drawings. The stiles and rails shall be joined by mortice and tenon joints at right angles. All members of the shutter shall be straight without any warp or bow and shall have smooth, well planed faces at right angles to each other. The right angle for the shutter shall be checked by measuring the diagonals and the difference shall not be more than ± 3 mm. Timber panels made from more than one piece shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. The workmanship shall generally conform to the requirements specified in IS: 1003 (Parts 1 & 2). The thickness of the shutter, width/thickness of the stiles/rails/panel type shall be as specified. Marine plywood panels conforming to IS: 710 shall be used for doors where specified.

Details of the wooden flush door shutters, solid core type with specific requirement of the thickness, core, face panels, viewing glazed panel, venetian louvre opening, teak wood lipping etc. shall be as specified. Panels of shutter shall be of marine plywood conforming to IS: 710. Flush door shutters shall be from reputed manufacturers and Contractor shall submit test results as per IS: 4020, if so desired by the Engineer.

Glazing of door, window, ventilator and partitions shall be with either flat transparent sheet glass, wired or figured glass. Transparent sheet glass shall be of 'B' quality as per IS: 2835.The thickness and type of glazing to be provided shall be as specified in the item of work.

The material of the fittings and fixtures either of chromium plated steel, cast brass, copper oxidised or anodised aluminium shall be as specified. The number, size and type of the fittings and fixtures shall be as indicated in the drawings/item of work.

Wood work shall not be provided with the finishes of painting/varnishing etc. unless it has been approved by the Engineer. The type of finish and the number of coats shall be as stipulated in the respective items of work.

Wooden hand railing and architraves shall be of the size and shape with the fixing arrangement as indicated in the drawings.

The framework of the partitions with mullions and transomes shall be with the sections of dimensions as specified. Panels of double/single glazing/plywood shall be fixed as per details specified. Partitions shall be fixed rigidly between the floor and structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the Construction drawings.

Any carpentry work which shows defects due to inadequate seasoning of the timber or bad workmanship shall be removed and replaced by Contractor with work as per Specifications at no extra cost to the Employer.

8.8.3 Measurement

Measurement for doors, windows, ventilators, architraves and partitions shall be in sq.m correct to two places of decimal. Handrailing shall be measured in running metres correct to two places of decimal. Measurement shall be from out to out of the frames. Rates quoted shall be for all the works including glazing, painting, Builder’s hardware of fittings and fixtures as specifically described in the respective items of work.

8.9 Steel Doors, Windows and Ventilators

8.9.1 Materials

Hot rolled steel sections for the fabrication of steel doors, windows and ventilators shall conform to IS: 7452 which are suitable for single glazing.

Pressed steel door frames for steel flush doors shall be out of 1.25mm thick mild steel sheets of profiles as per IS : 4351.

Transparent sheet glass shall conform to the requirements of IS : 2835. Wired and figured glass shall be as per IS: 5437.

Builder's hardware of fittings and fixtures shall be of the best quality from the approved manufacturers.

8.9.2 Workmanship

All steel doors, windows and ventilators shall be of the type as specified in the respective items of work and of sizes as indicated in the drawings. Steel doors, windows and ventilators shall conform to the requirements as stipulated in IS : 1038. Steel windows shall conform to IS : 1361, if so specified.

Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the unit shall be with rolled section, cut to correct lengths and mitred. Corners shall be welded to form a solid fused welded joint conforming to the requirements of IS : 1038. Tolerance in overall dimensions shall be within ±1.5mm. The frames and shutters shall be free from wrap or buckle and shall be square and truly plain. All welds shall be dressed flush on exposed and contact surfaces. Punching of holes, slots and other provisions to install fittings and fixtures later shall be made at the correct locations as per the requirements. Samples of the units shall be got approved by the Engineer before further manufacture/purchase by the Contractor.

Type and details of shutters, hinges, glazing bar requirement, couplings, locking arrangement, fittings and fixtures shall be as described in the respective items of work and / or as shown in the drawings for single or composite units.

For windows with fly proof mesh as per the item of work, rotor operator arrangement, for the operation of the glazed shutters from the inside shall be provided.

Pressed steel door frames shall be provided with fixing lugs at each jamb, hinges, lock-strike plate, mortar guards, angle threshold, shock-absorbers of rubber or similar material as per the requirements of IS : 4351. Pressed steel door frames shall be fixed as `built-in' as the masonry work proceeds. After placing it plumb at the specified location, masonry walls shall be built up solid on either side and each course grouted with mortar to ensure solid contact with the door frame, without leaving any voids. Temporary struts across the width shall be fixed, during erection to prevent bow/sag of the frame.

Door shutters of flush welded construction shall be 45mm thick, fabricated with two outer skins of 1.25mm thick steel sheets, 1mm thick steel sheet stiffeners and steel channels on all four edges. Double shutters shall have meeting stile edge bevelled or rebated. Provision of glazed viewing panel, louvers shall be made as per the items of works and/or drawings. Shutters shall be suitably reinforced for lock and other surface hardware and to prevent sagging/twisting. Single sheet steel door shutters shall be fabricated out of 1.25mm thick steel sheets, mild steel angles and stiffeners as per the drawings.

Doors, windows and ventilators shall be fixed into the prepared openings. They shall not be 'built-in' as the masonry work proceeds, to avoid distortion and damage of the units. The dimensions of the masonry opening shall have 10mm clearance all-round the overall dimensions of the frame for this purpose. Any support of scaffolding members on the frames/glazing bars is prohibited.

Glazing of the units shall be either with flat transparent glass or wired / figured glass of the thickness as specified in the items of works. All glass panels shall have properly squared corner and straight edges. Glazing shall be provided on the outside of the frames.

Fixing of the glazing shall be either with spring glazing clips and putty conforming to IS:419 or with metal beads. Pre-formed PVC or rubber gaskets shall be provided for fixing the beads with the concealed screws. The type of fixing the glazing shall be as indicated in the items of work and/or in drawings.

Steel doors, windows and ventilators shall be provided with finish of either painting as specified or shall be hot dip galvanised with thickness of the zinc coating as stipulated all as described in the respective items of works.

The material of the Builders hardware of fittings and fixtures of chromium plated steel, cast brass, brass copper oxidised or anodised aluminium shall be as specified in the items of works. The number, size and type of fittings and fixtures shall be as in the Drawings /items of work.

Installation of the units with fixing lugs, screws, mastic caulking compound at the specified locations shall generally conform to the requirements of IS:1081. Necessary holes etc required for fixing shall be made by the Contractor and made good after installation. Workmanship expected is of a high order for efficient and smooth operation of the units.

8.9.3 Measurement

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be from out to out of the frames. Rates quoted shall be for the works including glazing, painting, Builder's hardware of fittings and fixtures as specifically described in the respective items of work.

8.10 Aluminium Doors, Windows, Ventilators & Partitions

8.10.1 Materials

Aluminium alloy used in the manufacture of extruded sections for the fabrication of doors, windows, ventilators shall conform to designation HE9-WP of IS:733.

Transparent sheet glass shall conform to the requirements of IS:2835. Wired and figured glass shall be as per IS:5437.

Builder's hardware of fittings & fixtures shall be of the best quality from approved manufacturers.

8.10.2 Workmanship

All aluminum doors, windows, ventilators and partitions shall be of the type and size as specified. The doors, windows, ventilators shall conform to the requirements of IS:1948. Aluminum windows, shall conform to IS:1949, if so specified.

All aluminum units shall be supplied with anodized finish. The minimum anodic film thickness shall be 0.015 mm.

Doors, windows and ventilators shall be of an approved manufacturer. Fabrication of the units shall be with the extruded sections, cut to correct lengths, mitred and welded at the corners to a true right angle conforming to the requirements of IS:1948. Tolerance in overall dimensions shall be within ± 1.5mm. The frames and shutters shall be free from warp or buckle and shall be square and truly plane. Punching of holes, slots and other provisions to install fittings or fixtures later shall be made at the correct locations, as per the requirements.

Aluminium swing type doors, aluminum sliding windows, partitions shall be as described in the items of work / drawings.

IS:1948 and IS:1949 refers to incorporating the sizes, shapes, thicknesses and weight per running metre of extruded sections for various components of the units. However, new sizes, shapes, thicknesses with modifications to suit snap-fit glazing clips etc. are continuously being added by various leading manufacturers of extruded sections, which are available in the market. As such, the sections of the various components of the unit proposed by the Contractor will be reviewed by the Engineer and will be accepted only if they are equal to or marginally more than that given in the codes / specified in the items of work.

The framework of the partitions with mullions and transoms shall be made of anodized aluminum box sections. Anodised aluminium box sections shall be in-filled with timber of class 3 (silver oak or any other equivalent) as per IS:4021. Panels of double/single glazing/plywood shall be fixed as per details indicated in the drawings. Partitions shall be fixed rigidly between the floor and the structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction drawings.

Specific provisions as stipulated for steel doors, windows, ventilators under clause 8.9.2 shall also be applicable for this item work. Glazing beads shall be of the snap-fit type suitable for the thickness of glazing proposed as indicated in the items of works. A layer of clear transparent lacquer shall be applied on aluminium sections to protect them from damage during installation. This lacquer coating shall be removed after the installation is completed.

8.10.3 Measurement

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be from out of the frames. Rate quoted shall be for the works including glazing, Builder's hardware of fittings and fixtures as specifically described in the respective items of work.

8.11 Steel Rolling Shutters

8.11.1 Materials and Workmanship

Rolling shutters shall be of an approved manufacture, conforming to the requirements specified in IS: 6248.

The type of rolling shutter shall be self coiling type (manual) for clear areas upto 12 sq.m, gear operated type (mechanical) for clear areas upto 35 sq.m and electrically operated type for areas upto 50 sq.m. Mechanical type of rolling shutters shall be suitable for operation from both inside and outside with the crank handle or chain gear operating mechanism duly considering the size of wall/column. Electrical type of rolling shutter shall also be provided with a facility for emergency mechanical operation.

Rolling shutters shall be supplied duly considering the type, specified clear width/height of the opening and the location of fixing as indicated in the drawings.

Shutters shall be built up of interlocking laths 75 mm width between rolling centres formed from cold rolled steel strips. The thickness of the steel strip shall not be less than 0.90 mm for shutters

upto 3.50m width and not less than 1.20 mm for shutters above 3.50 m width. Each lath section shall be continuous single piece without any welded joint.

The guide channels out of mild steel sheets of thickness not less than 3.15 mm shall be of either rolled, pressed or built up construction. The channel shall be of size as stipulated in IS:6248 for various clear widths of the shutters.

Hood covers shall be of mild steel sheets not less than 0.90 mm thick and of approved shape.

Rolling shutters shall be provided with a central hasp and staple safety device in addition to one pair of lever locks and sliding locks at the ends.

All component parts of the steel rolling shutter (excepting springs and insides of guide channels) shall be provided with one coat of zinc chrome primer conformity to IS:2074 at the shop before supply. These surfaces shall be given an additional coat of primer after erection at the site along with the number of coats and type of finish paint as specified in the respective items of work.

In case of galvanized rolling shutter, the lath sections, guides, lock plate, bracket plates, suspension shaft and the hood cover shall be hot dip galvanised with a zinc coating containing not less than 97.5 percent pure zinc. The weight of the zinc coating per sq.m shall be as specified in the items of work.

Guide channels shall be installed truly plumb at the specified location. Bracket plate shall be rigidly fixed with necessary bolts and holdfasts. Workmanship of erection shall ensure strength and rigidity of rolling shutter for trouble free and smooth operation.

8.11.2 Measurement

Measurement shall be in sq.m correct to two places of decimal of the clear area of the opening. Quoted rate shall be inclusive of painting as specified in the item of work.

8.12 Rubble Sub-Base

8.12.1 Materials

Stones used for rubble packing under floors on grade, foundations etc., shall be clean, hard, durable rock free from veins, flaws, laminations, weathering and other defects. Stones shall generally conform to the requirements stipulated in IS: 1597 (Part I).

Stones shall be as regular as can be obtained from quarries. Stones shall be of height equal to the thickness of the packing proposed with a tolerance of $\pm$ 10 mm. Stones shall not have a base area neither less than 250 sq cm nor more than 500 sq.cm, and the smallest dimension of any stone shall not be less than half the largest dimension. The quality and size of stones shall be subject to the approval of the Engineer.

8.12.2 Workmanship

Stones shall be hand-packed carefully and laid with their largest base downwards, resting flat on the prepared sub-grade and with their height equal to the thickness of the packing. Stones shall be laid breaking joints and in close contact with each other. All interstices between the stones shall be wedged-in by small stones of suitable size, well driven in by crow bars and hammers to ensure tight packing and complete filling-in of the interstices. The wedging shall be carried out

simultaneously with the placing in position of rubble packing and shall not lag behind. After this, any interstices between the smaller wedged stones shall be infilled with clean hard sand by brooming so as to fill the joints completely.

The laid rubble packing shall be sprinkled with water and compacted by using suitable rammers.

8.12.3 Measurement

Measurement shall be in sq.m correct to two places of decimal for the specified compacted thickness of rubble sub-base.

8.13 Base Concrete

The thickness and grade of concrete and reinforcement shall be as specified in items of work.

Before placing the blinding concrete, the sub-base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms, thoroughly tamped and the surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

8.13.1 Measurement

Measurement shall be in sq.m correct to two places of decimal. This work could be either separate or combined along with the floor finish as indicated in the respective items of work.

8.14 Terrazzo and Plain Cement Tiling Work

8.14.1 Materials

Terrazzo tiles and cement tiles shall generally conform in all respects to standards stipulated in IS: 1237. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than $14N/mm^2$.

The type, quality, size, thickness colour etc, of the tiles for flooring/dado/skirting shall be as specified in the items of work.

The aggregates for terrazzo topping shall consist of marble chips that are hard, sound, and dense. Cement to be used shall be either ordinary Portland cement or white cement with or without colouring pigment. The binder mix shall be 3 parts of cement to 1 part of marble powder by weight. The proportion of cement shall include any pigments. For every one part of cement-marble powder binder mix, the proportion of aggregates shall be 1.75 parts by volume, if the chips are between 1mm to 6mm and 1.50 parts by volume if the chips are between 6mm to 25mm.

The minimum thickness of the wearing layer of terrazzo tiles shall be 5mm for tiles with chips of size varying from 1mm up to 6mm or from 1mm up to 12mm. This shall be 6mm for tiles with chips varying from 1mm upto 25mm. The minimum thickness of wearing layer of cement/coloured cement tiles shall be 5mm. This shall be 6mm for heavy-duty tiles. The pigment used in the wearing layer shall not exceed 10 percent of the total weight of cement used in the mix.

8.14.2 Workmanship

Laying and finishing of tiles shall conform to the requirements of workmanship stipulated in IS:1443.

Tiling work shall be commenced only after the door and window frames are fixed and plastering of the walls/ ceiling is completed. Wall plastering shall not be carried out upto about 50mm above the level of proposed skirting/dado.

The base concrete shall be finished to a reasonably plane surface about 40 to 45mm below the level of finished floor. Before the tiling work is taken up, the base concrete or structural slab shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. using steel wire brush and well wetted without allowing any water pools on the surface.

A layer of 25mm average thickness of cement mortar consisting of one part of cement to 6 parts of sand shall be provided as bedding for the tiles over the base concrete. The thickness of bedding mortar shall not be less than 10mm at any place. The quantity of water to be added for the mortar shall be just adequate to obtain the workability for laying. Sand for the mortar shall conform to IS:2116 and shall have minimum fineness modulus of 1.5. The surface shall be left rough to provide a good bond for the tiles. The bedding shall be allowed to harden for a day before laying of the tiles.

Neat cement slurry using 4.4 kg of cement per sq.m of floor area shall be spread over the hardened mortar bedding over such an area at a time as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be in straight lines and shall normally be 1.5mm wide. On completion of laying of the tiles in a room, all the joints shall be cleaned and washed fairly deep with a stiff broom/wire brush to a minimum depth of 5mm. The day after the tiles have been laid, the joints shall be filled with cement grout of the same shade as the colour of the tile matrix. For this purpose, white cement or grey cement with or without pigments shall be used. The flooring should be kept moist and left undisturbed for 7 days to allow the bedding and joints to set properly. Heavy traffic shall not be allowed on the floor for atleast 14 days after fixing of the tiles.

About a week after laying the tiles, each tile shall be lightly tapped with a small wooden mallet to determine if it produces a hollow sound. If it does, the affected tiles, along with any other cracked or broken tiles, shall be removed and replaced with new tiles to ensure proper line and level. The same procedure shall be followed again after grinding the tiles, and all damaged tiles shall be replaced, properly jointed, and finished to match. To ensure that the replaced tiles match those laid earlier, it is necessary for the Contractor to procure a sufficient quantity of extra tiles to meet this contingency.

Wherever a full tile cannot be provided, tiles shall be cut to size and fixed. Floor tiles adjoining the wall shall go about 10mm under the plaster, skirting or dado.

Tile skirting and dado work shall be executed only after laying tiles on the floor. For dado and skirting work, the vertical wall surface shall be thoroughly cleaned and wetted. Thereafter, it shall be evenly and uniformly covered with a 10mm thick backing of 1:4 cement-sand mortar. For this work the tiles as obtained from the factory shall be of the size required and practically full polished. The back of each tile to be fixed shall be covered with a thin layer of neat cement paste

and the tile shall then be gently tapped against the wall with a wooden mallet. Fixing shall be done from the bottom of the wall upwards. The joints shall be in straight lines and shall normally be 1.5mm wide. Any difference in the thickness of the tiles shall be evened out in the backing mortar or cement paste so that the tile faces are in conformity & truly plumb. Tiles for use at the corners shall be suitably cut with bevelled edges to obtain a neat and true joint. After the work has set, hand polishing with carborundum stones shall be done so that the surface matches with the floor finish. Contractor shall note that the unit rate quoted for skirting shall also include for any chipping of the brickwork required to be carried out for this item.

Wall plastering of the strip left out above the level of skirting/dado shall be taken up after the tiles are fixed.

Chequered terrazzo tiles for flooring and for stair treads shall be delivered to site after the first machine grinding.

Machine grinding and polishing shall commence only after a 14-day lay period. The sequence and three numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pin holes, watering etc. shall be carried out all as specified in IS:1443.

Tiles shall be laid to the levels specified. Where large areas are to be tiled the level of the central portion shall be kept 10mm higher than that at the walls to overcome optical illusion of a depression in the central portion. Localized deviation of ±3mm in any 3m length is acceptable in a nominally flat floor.

8.14.3 Measurement

Measurement for floor tiling and dado shall be in sq. m, correct to two decimal places. Actual quantity of tiling work as laid shall be measured for payment as per the respective items of work after making deductions for openings etc. Measurement for skirting shall be in running metres correct to two places of decimal for the specified height as per the item of work.

8.15 In-Situ Terrazzo Work

8.15.1 Materials

The requirements of marble aggregates for terrazzo topping shall be as per clause 8.14.1.

Cement shall first be mixed with the marble powder in dry state. The mix thus obtained shall be mixed with the aggregates in the specified proportions. Care shall be taken not to get the materials into a heap which results in the coarsest chips falling to the edges and cement working to the centre at the bottom. Materials shall be kept, as far as possible, in an even layer during mixing. After the materials have been thoroughly mixed in the dry state, water shall be added, just adequate to obtain plastic consistency for the desired workability for laying. The mix shall be used in the works within 30 minutes of the addition of water to the cement.

8.15.2 Workmanship

The thickness, type, quality, size and colour of chips etc. for the in-situ terrazzo finish for flooring/dado/ skirting shall be as specified in the respective items of works. Laying and finishing of in-situ work shall conform to the requirements of workmanship stipulated in IS: 2114.

In-situ terrazzo finish shall be laid over hardened concrete base. The finish layer consists of an under layer and terrazzo topping. The underlayer shall be of cement concrete of mix 1:2:4 using 10mm down graded coarse aggregates. The combined thickness of under layer and topping shall not be less than 30 mm for flooring and 20mm for dado/skirting work.

The minimum thickness of topping shall be 6mm if chips used are between 1mm to 4mm, 9mm if chips are between 4mm to 7mm and 12mm if chips are between 7mm to 10mm. If chips larger than 10mm size are used, the minimum thickness shall be one and one third the maximum size of chips.

Both the under layer and later the topping shall be divided into panels not exceeding 2 sq.m for laying so as to reduce the possibility of development of cracks. The longer dimension of any panel shall not exceed 2m. Dividing strips shall be used to separate the panels. When the dividing strips are not provided, the bays shall be laid alternately, allowing an interval of atleast 24 hours between laying adjacent bays.

Dividing strips shall be either of aluminium, brass or other material as indicated in the items of works. Aluminum strips should have a protective coating of bitumen. The thickness of the strips shall be not less than 1.5mm and width not less than 25mm for flooring work.

Concrete base shall be finished to a reasonably plane surface to a level below the finished floor elevation equal to the specified thickness of terrazzo finish. Before spreading the underlayer, the base concrete surface shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. and well wetted without allowing any water pools on the surface. Dividing strips or screed strips, if dividing strips are not provided shall be fixed on the base and levelled to the correct height to suit the thickness of the finish. Just before spreading the underlayer the surface shall be smeared with cement slurry at 2.75 Kg/sq.m. Over this slurry, the underlayer shall be spread and levelled with a screening board. The top surface shall be left rough to provide a good bond for the terrazzo topping.

Terrazzo topping shall be laid while the underlayer is still plastic and normally between 18 to 24 hours after the underlayer is laid. Cement slurry of the same colour as the topping shall be brushed on the surface immediately before laying is commenced. The terrazzo mix shall be laid to a uniform thickness and compacted thoroughly by tamping and with a minimum of troweling. Straight edge and steel floats shall be used to bring the surface true to the required level in such a manner that the maximum amount of marble chips come up and spread uniformly all over the surface.

The surface shall be left dry for air-curing for a period of 12 to 18 hours. Thereafter, it shall be cured by allowing water to stand in pools for a period of not less than 4 days.

Machine grinding and polishing shall be commenced only after a lapse of 7 days from the time of completion of laying. The sequence and four numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pinholes, wet curing, watering etc shall be carried out all as specified in IS: 2114.

8.15.3 Measurement

Measurement shall be as per clause 8.14.3.

8.16 Shahabad / Tandur/ Kota Stone Slab/ Granite flooring work

8.16.1 Materials

The slabs shall be of approved selected quality, hard, sound, dense and homogenous in texture, free from cracks, decay, weathering and flaws. The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS : 1124.

The slabs shall be hand or machine cut to the required thickness. Tolerance in thickness for dimensions of tile more than 100mm shall be ±5mm. This shall be ±2mm on dimensions less than 100mm.

Slabs shall be supplied to the specified size with machine cut edges or fine chisel dressed to the full depth. All angles and edges of the slabs shall be true and square, free from any chipping giving a plane surface. Slabs shall have the top surface machine polished (first grinding) before being brought to site. The slabs shall be washed clean before laying.

8.16.2 Workmanship

The type, size, thickness and colour/shade etc. of the slabs for flooring/dado/skirting shall be as specified in the respective items of work.

Preparation of the concrete base, laying and curing shall be as per clause 8.14.2.

Dado / skirting work shall be as per clause 8.14.2. The thickness of the slabs for dado/skirting work shall not be more than 25mm. Slabs shall be so placed that the back surface is at a distance of 12mm. If necessary, slabs shall be held in position temporarily by suitable method. After checking for verticality, the gap shall be filled and packed with cement sand mortar of proportion 1:3. After the mortar has acquired sufficient strength, the temporary arrangement holding the slab shall be removed.

Grinding and polishing shall be as per clause 8.14.2 except that first grinding with coarse grade carborundum shall not be done and cement slurry with or without pigment shall not be applied before polishing.

8.16.3 Measurement

Measurement shall be as per clause 8.14.3.

8.17 Carborundum Tile Finish

8.17.1 Materials

Carborundum tiles shall generally conform in all respects to the standards stipulated in IS:1237 for heavy duty tiles. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than 14 N/mm^2.

The topping shall be uniform and of thickness not less than 6mm. The quantity of carborundum grit shall be not less than 1.35 kg/sq.m used with cement with or without pigment. The carborundum grit shall pass through 1.18mm mesh and shall be retained on 0.60 mm mesh.

The size, thickness, colour and plain or chequered etc of the tiles for flooring / skirting shall be as specified in the respective items of work.

8.17.2 Workmanship

Requirements as detailed for terrazzo/cement tile finish under clause 8.14.2 shall be applicable for carborundum tile flooring.

8.17.3 Measurement

Measurement shall be as per clause 8.14.3.

8.18 Glazed Tile Finish

8.18.1 Materials

Glazed earthenware tiles shall conform to the requirements of IS: 777. Tiles shall be of the best quality from an approved manufacturer. The tiles shall be flat, true to shape and free from flaws such as crazing, blisters, pinholes, specks or welts. Edges and underside of the tiles shall be free from glaze and shall have ribs or indentations for a better anchorage with the bedding mortar. Dimensional tolerances shall be as specified in IS: 777.

8.18.2 Workmanship

The size, thickness, colour, with or without designs etc of the tiles for flooring/dado/skirting shall be as specified in the respective items of work.

The total thickness of glazed tile finish including the bedding mortar shall be 20 mm in flooring/dado/skirting. The minimum thickness of bedding mortar shall be 12mm for flooring and 10mm for dado/skirting work.

The bedding mortar shall consist of 1 part of cement to 3 parts of sand mixed with just sufficient water to obtain proper consistency for laying. Sand for the mortar shall conform to IS: 2116 and shall have minimum fineness modulus of 1.5.

Tiles shall be soaked in water for about 10 minutes just before laying. Where full size tiles cannot be fixed, tiles shall be cut to the required size using special cutting device and the edges rubbed smooth to ensure straight and true joints.

Colored tiles with or without designs shall be uniform and shall be preferably procured from the same batch of manufacture to avoid any differences in the shade.

Tiles for the flooring shall be laid over hardened concrete base. The surface of the concrete base shall be cleaned of all loose materials, mortar droppings etc well wetted without allowing any water pools on the surface. The bedding mortar shall then be laid evenly over the surface, tamped to the desired level and allowed to harden for a day. The top surface shall be left rough to provide a good bond for the tiles. For skirting and dado work, the backing mortar shall be roughened using a wire brush.

Neat cement slurry using 3.3 kg cement per sq.m of floor area shall be spread over the hardened mortar bed over such an area as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. For skirting and dado work, the back of the tiles shall be smeared with cement slurry for setting on the backing mortar. Fixing of tiles shall be done from the bottom of the wall upwards. The joints shall be in perfect straight lines and as thin as

possible but shall not be more than 1mm wide. The surface shall be checked frequently to ensure correct level/required slope. Floor tiles near the walls shall enter skirting/dado to a minimum depth of 10mm. Tiles shall not sound hollow when tapped.

All the joints shall be cleaned of grey cement with wire brush to a depth of atleast 3mm and all dust, loose mortar etc. shall be removed. White cement with or without pigment shall then be used for flush pointing the joints. Curing shall then be carried out for a minimum period of 7 days for the bedding and joints to set properly. The surface shall then be cleaned using a suitable detergent, fully washed and wiped dry.

Specials consisting of coves, internal and external angles, cornices, beads and their corner pieces shall be of thickness not less than the tiles with which they are used.

8.18.3 Measurement

Measurement shall be as per Clause 8.14.3.In-Situ Cement Concrete Floor Topping

8.18.4 Materials

The mix proportion for the in-situ concrete floor topping shall be 1:2.5:3.5 (one part cement: two and half parts sand: three and half parts coarse aggregates) by volume unless otherwise specified in the items of work.

The aggregates shall conform for the requirements of IS: 383.

Coarse aggregates shall have high hardness surface texture and shall consist of crushed rock of granite, basalt, trap or quartzite. The aggregate crushing valve shall not exceed 30 percent. The grading of the aggregates of size 12.5mm and below shall be as per IS: 2571.

Grading of the sand shall be within the limits indicated in IS: 2571.

8.18.5 Workmanship

The thickness of the floor topping shall be as specified in the items of work. The minimum thickness of the floor topping shall be 25mm.

Preparation of base concrete/structural slab before laying the topping shall be as per clause 8.13. The surface shall be rough to provide adequate bond for the topping.

Mixing of concrete shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the Engineer. The concrete shall be as stiff as possible and the amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and compacting. The mix shall be used in the work within 30 minutes of the addition of water for its preparation.

Floor finish shall be laid in suitable panels to reduce the risk of cracking. No dimension of a panel shall exceed 2 meters and the length of a panel shall not exceed one and a half times its breadth. Topping shall be laid in alternate panels, the intermediate panels being cast after a gap of atleast one day. Construction joints shall be plain vertical butt joints.

Screed strips shall be fixed dividing the area into suitable panels. Immediately before depositing the concrete topping, neat cement slurry at 2.75 kg/sq.m of area shall be thoroughly brushed into

the prepared surface. Topping shall then be laid, very thoroughly tamped, struck off level and floated with wooden float. The surface shall then be tested with a straight edge and mason's spirit level to detect any inequalities and these shall be made good immediately.

Finishing of the surface by troweling shall be spread over a period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowelled 3 times at intervals so as to produce a smooth uniform and hard surface. Immediately after laying, the first trowelling just sufficient to give a level surface shall be carried out avoiding excessive trowelling at this stage. The surface shall be re- trowelled after sometime to close any pores and to scrap off excess water or laitance, which shall not be trowelled back into the topping. Final trowelling shall be done well before the concrete has become too hard but at a time when considerable pressure is required to make any impression on the surface. Sprinkling of dry cement or cement-sand mixture for absorbing moisture shall not be permitted.

Immediately after the surface is finished, it shall be protected suitably from rapid drying due to wind/ sunlight. After the surface has hardened sufficiently to prevent any damage to it, the topping shall be kept continuously moist for a minimum period of 10 days.

It is preferable to lay the topping on hardened base concrete, as against being laid monolithically with a lesser thickness, since proper levels and slopes with close surface tolerances is achievable in practice, owing to its greater thickness. Further, as this would be laid after all other building operations are over, there will be no risk of any damages or discoloration to the floor finish which are difficult to repair satisfactorily.

8.18.6 Measurement

Measurement shall be in sq.m correct upto two places of decimal.

8.19 In-Situ Granolithic Concrete Floor Topping

8.19.1 Materials and Workmanship

The requirements of materials and workmanship shall be all as per clause 8.19 for in-situ cement concrete floor topping except that the mix proportion of the concrete shall be 1:1:2 (cement:sand:coarse aggregates) by volume.

The minimum thickness of granolithic floor topping on hardened concrete base shall be 40mm.

8.19.2 Measurement

Measurement shall be in sq.m correct upto two places of decimal.

8.20 Floor Hardener Topping

8.20.1 Materials & Workmanship

Floor hardener topping shall be provided either as integrally finished over the structural slab/grade slab or laid monolithically with the concrete/granolithic floor finish on top of hardened concrete base.

Floor hardener of the metallic or non-metallic type suitable for the performance of normal / medium/ heavy duty function of the floor, the quantum of ingredients and the thickness of topping shall be as specified in the respective items of work.

For monolithic application with the floor finish/slab the thickness of the layer shall be 15mm. The topping shall be laid within 2 to 3 hours after concrete is laid when it is still plastic but stiffened enough for the workmen to tread over it by placing planks. The surface of the concrete layer shall be kept rough for providing adequate bond for the topping. Laitance shall be removed before placing the topping. The topping shall be screened and thoroughly compacted to the finished level. Trowelling to a smooth finish shall be carried out as per clause 8.19.2. After the surface has hardened sufficiently, it shall be kept continuously moist for atleast 10 days.

The procedure for mixing the floor hardener topping shall be as per manufacturer's instructions.

Surface shall be prevented from any damages due to subsequent building operations by covering with 75 mm thick layer of sand.

8.20.2 Measurement

Measurement shall be in sq.m correct to two places of decimal. This could be either separate or combined along with the floor finish as indicated in the respective items of work.

8.21 PVC Sheet/Tile Flooring

8.21.1 Materials

PVC floor covering shall be of either unbacked homogeneous flexible type in the form of sheets/tiles conforming to IS: 3462 or homogeneous PVC asbestos tiles conforming to IS:3461.

The surface of the sheets/tiles shall be free from any physical defects such as pores, blisters, cracks etc. which affects the appearance and serviceability. Tiles/ sheets shall meet with the tolerance limits in dimensions specified in the IS. Contractor shall submit the test certificates, if so desired by the Engineer.

Each tile/sheet shall be legibly and indelibly marked with the name of the manufacturer or his trade mark, IS certificate mark, and batch number.

The adhesive to be used for laying the PVC flooring shall be rubber based and of the make as recommended and approved by the manufacturer of PVC sheets/tiles.

The type, size, colour, plain or mottled and the pattern shall be as specified in the respective items of work.

8.21.2 Workmanship

PVC floor covering shall be provided over an underbed of cement concrete floor finish over the base concrete or structural slab. The sub-floor and the underbed must be perfectly dry before laying the PVC flooring. This shall be ensured by methods of testing as stipulated in Appendix-A of IS: 5318.

The surface of the underbed shall have trowelled finish without any irregularities which creates poor adhesion. Surface shall be free of oil or grease and thoroughly cleaned of all dust, dirt and wiped with a dry cloth.

PVC sheets/tiles shall be brought to the temperature of the area in which they are to be laid by stacking in a suitable manner within or near the laying area for a period of about 24 hours. Where air-conditioning is installed, the flooring shall not be laid on the underbed until the A/C units have been in operation for atleast 7 days. During this period, the temperature range shall be between 20deg.C and 30deg.C and this shall be maintained during the laying operations and also for 48 hours thereafter.

Layout of the PVC flooring shall be marked with guidelines on the underbed and PVC tiles/sheets shall be first laid for trial, without using the adhesive, according to the layout.

The adhesive shall be applied by using a notched trowel to the surface of the underbed and to the backside of PVC sheets/tiles. When the adhesive has set sufficiently for laying, it will be tacky to the touch, which generally takes about 30 minutes. The time period need be carefully monitored since a longer interval will affect the adhesive properties. Adhesive shall be uniformly spread over only as much surface area at one time which can be covered with PVC flooring within the stipulated time.

PVC sheet shall be carefully taken and placed in position from one end onwards slowly so that the air will be completely squeezed out between the sheet and the background surface and no air pockets are formed. It shall then be pressed with a suitable roller to develop proper contact. The next sheet shall be laid edge to edge with the sheet already laid, so that there is minimum gap between joints. The alignment shall be checked after each row of sheet is completed and trimmed if considered necessary.

Tiles shall be laid in the same manner as sheets and preferably, commencing from the centre of the area. Tiles should be lowered in position and pressed firmly on to the adhesive with minimum gap between the joints. Tiles shall not be slided on the surface. Tiles shall be rolled with a light wooden roller of about 5kg to ensure full contact with the underlay. Work should be constantly checked to ensure that all four edges of adjacent tiles meet accurately.

Any excess adhesive which may squeeze up between sheets/tiles shall be wiped off immediately with a wet cloth. Suitable solvents shall be used to remove hardened adhesive.

A minimum period of 24 hours shall be given after laying for the development of proper bond of the adhesive. When the flooring is thus completed, it shall be cleaned with a wet cloth soaked in warm soap solution.

Metallic edge strips shall be used to protect the edges of PVC sheets/tiles which are exposed as in doorways/ stair treads.

Hot sealing of joints between adjacent PVC sheet flooring to prevent creeping of water through the joints shall be carried out, using special equipment as per manufacturer's instructions.

8.21.3 Measurement

Measurement shall be in sq.m correct to two places of decimal. The item could be either separate or as a combined item with the floor finish as specified in the respective items of work.

8.22 Acid Resisting Brick/Tiling Work

8.22.1 Materials

The ceramic unglazed vitreous acid resisting tiles shall conform to the requirements of IS: 4457. Acid resistant bricks shall conform to the requirements of IS: 4860.

The finished tile/brick when fractured shall appear fine grained in texture, dense and homogeneous. Tile/brick shall be sound, true to shape, flat, free from flaws and any manufacturing defects affecting their utility. Tolerance in dimensions shall be within the limits specified in the respective IS.

The tiles/bricks shall be bedded and jointed using chemical-resistant mortar of the resin type conforming to IS: 4832 (Part II). Method of usage shall generally be as per the requirements of IS: 4443.

8.22.2 Workmanship

The size and thickness of tiles/size and class of bricks for use in the flooring/skirting/dado shall be as specified in the respective items of work.

The resin shall have viscosity for readily mixing with the filler by manual methods. The filler shall have graded particles which permit joint thickness of 1.5 mm.

The base concrete surface shall be free from dirt and thoroughly dried. The surface shall be applied with a coat of bitumen primer conforming to IS:3384. The primed surface shall then be applied with a uniform coat of bitumen conforming to IS:1580. Tiles or bricks shall be laid directly without the application of bitumen, if epoxy or polyester resin is used for the mortar.

A sufficient quantity of mortar, as specified by the manufacturer, shall be prepared at one time for bedding and jointing purposes. Rigid PVC, stainless steel, and chromium-plated tools shall be used for mixing and laying.

For laying the floor 6 to 8 mm thick mortar shall be spread on the back of the tile/brick. Two adjacent sides of the tile/brick shall be smeared with 4 to 6 mm thick mortar. Tile/brick shall be pressed into the bed and pushed against the floor, and with the adjacent tile/brick, until the joint in each case is 2 to 3 mm thick. The excess mortar shall then be trimmed off and allowed to harden completely. Similar procedure shall be adopted for the work on walls by pressing the tile/brick against the prepared wall surfaces, and only one course shall be laid at a time until the initial setting period.

The mortar joints shall be cured for a minimum period of 72 hours with 20 to 25% hydrochloric acid or 30 to 40% sulphuric acid. After acid curing, the joints shall be washed with water and allowed to thoroughly dry. The joints shall then be filled with mortar to make them smooth and plane. Acid curing is not required to be carried out if epoxy or polyester resin is used for the mortar.

Resin mortars are normally self curing. The area tiled shall not be put to use before 48 hours in case epoxy, polyester and furane type of resin is used for the mortar. If phenolic or cashewnut shell liquid resin is used for the mortar, the area tiled shall not be put to use for 7 to 28 days respectively, without heat treatment. This period shall be 2 to 6 days respectively, if heat treatment is given with infrared lamp.

8.22.3 Measurement

Measurement shall be in sq.m correct to two places of decimal for flooring/dado. Measurement shall be in running metres correct to two places of decimal for skirting of height as specified in the item of work.

8.23 Heavy Duty Abrasion Resistant Flooring

The type, quality, size, thickness, colour, etc., of the tile for flooring and skirting work shall be of the best quality approved by the Engineer. For this purpose, the Contractor shall provide the Engineer with necessary samples for this selection. Tiles shall be hardwearing, resistant to impact, resistant to abrasion, free from slipperiness and also resistant to attack by water, oils and greases.

8.24 Epoxy Lining Work

8.24.1 Materials

The epoxy resin and hardener formulation for laying of jointless lining work in floors and walls of concrete tanks/trenches etc shall be as per the requirements of IS: 9197.

The epoxy composition shall have the chemical resistance to withstand the following conditions of exposure:

a) Hydrochloric acid upto 30% concentration

b) Sodium hydroxide upto 50% concentration

c) Liquid temperature upto 60deg.C

d) Ultraviolet radiation

e) Alternate wetting and drying

Sand shall conform to grading zone III or IV of IS: 383.

The hardener shall be of the liquid type such as Aliphatic Amine or an Aliphatic/Aromatic Amine Adduct for the epoxy resin. The hardener shall react with epoxy resin at normal ambient temperature.

Contractor shall furnish test certificates for satisfying the requirements of the epoxy formulation if so directed by the Engineer.

8.24.2 Workmanship

The minimum thickness of epoxy lining shall be 4 mm. It is essential that the concrete elements are adequately designed to ensure that water is excluded to permeate to the surface, over which the epoxy lining is proposed.

The epoxy lining shall be of the trowel type to facilitate execution of the required thickness for satisfactory performance.

The concrete surfaces over which epoxy lining is to be provided shall be thoroughly cleaned of oil or grease by suitable solvents, wire brushed to remove any dirt/dust and laitance. The surfaces

shall then be washed with dilute hydrochloric acid and rinsed thoroughly with plenty of water or dilute ammonia solution. The surfaces shall then be allowed to dry. It is essential to ensure that the surfaces are perfectly dry before the commencement of epoxy application.

Just adequate quantity of epoxy resin which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for laying and jointing.

Rigid PVC/stainless steel/chromium plated tools shall be used for laying. Trowelling shall be carried out to obtain uniformly the specified thickness of lining.

Lining shall be allowed to set without disturbance for a minimum period of 24 hours. The facility shall be put to use only after a minimum period of 7 days of laying of the lining.

8.24.3 Measurement

Measurement shall be in sq.m correct to two places of decimal.

8.25 Water-Proofing

Machine-made flat Yelahanka tiles shall be of the size and thickness as specified in the item of work. Tiles shall be soaked in water for atleast one hour before laying. The tiles shall be laid on a mortar bed of cement mortar 1:3 with an average thickness of 25mm. Tiles shall be laid, open jointed with 4 to 6 mm wide joints, flat on the mortar and lightly pressed and to set to a plane surface true to slope, using a trowel and a wooden straight edge. They shall be laid with their longitudinal lines of joints truly parallel and generally at right angles to the direction of the run-off gradient. Transverse joints in alternate rows shall come directly in line with each other. Transverse joints in adjacent courses shall break joints by atleast 50 mm. The joints shall be filled and flush-pointed with a 1:3 cement mortar mixed with red oxide. Curing shall be carried out for a minimum period of seven days.

8.25.1 General

The work shall include waterproofing for the building roofs, terraces, toilets, floor slabs, walls, planters, chajjas, sills and any other areas and at any other locations and situations as directed by the Engineer.

The waterproofing treatment shall be carried out on top of lime concrete (brick bat coba) laid to slope on roof surfaces. The brick bat coba shall be covered as specified below.

The work shall be carried out by an experienced specialist Sub-Contractor who shall be appointed only after prior approval of the Engineer.

8.25.2 Modified Bituminous Membrane

Modified Bituminous Membrane shall be “SUPER THERMOLAY” 4 mm thick weighing 4 Kg/sqm, manufactured using APP Polymer modified bitumen with a central core of non-woven polyester reinforcement (200 gms/sqm) and with top and bottom layers of thermofusible film (top layer could also be sand finished) made by STP Limited in collaboration with Bitumat Company Limited. “PLYFLEX” of Bitumat Company Limited, Saudi Arabia supplied by STP Limited shall also be acceptable or other equivalent specification.

8.25.3 Waterproofing of Roofs with Lime Concrete

(a) Materials

Broken brick coarse aggregates prepared from well/over burnt bricks shall be well graded having a maximum size of 25mm and shall generally conform to IS:3068.

Lime shall be class C lime (fat lime) or factory-made hydrated lime conforming to IS:712.

(b) Workmanship

Lime concrete shall be prepared by thoroughly mixing the brick aggregates inclusive of brick dust obtained during breaking with the slaked lime in the proportions of 2 1/2 (two and a half) parts of brick aggregates to 1 part of slaked lime by volume. Water shall be added just adequate to obtain the desired workability for laying. Washing soap and alum shall be dissolved in the water to be used. The quantity of these materials required per cum of lime concrete shall be 12kg of washing soap and 4kg of alum. Brick aggregates shall be soaked thoroughly in water for a period of not less than six hours before use in the concrete mix. Lime concrete shall be used in the works within 24 hours after mixing.

The roof surface over which the water-proof treatment is to be carried out shall be cleaned of all foreign matter by wire brushing, dusting and made thoroughly dry. Preparation of surfaces shall be as stipulated in IS: 3067.

The slope of the finished waterproofing treatment shall be not less than 1 in 60 for efficient drainage. This shall be achieved either wholly in the lime concrete layer or otherwise as indicated in the drawings.

The average thickness of lime concrete, slope, and the finish on top of machine-made burnt clay flat terracing tiles conforming to IS:2690 (part I) shall be as specified in the items of work. Cement concrete flooring tiles in lieu of clay terracing tiles shall be provided if so specified in the items of work, duly considering the traffic the terrace will be subjected to.

The minimum compacted thickness of lime concrete layer shall be 75mm and average thickness shall not be less than 100mm. In case, the thickness is more than 100mm, it shall be laid in layers not exceeding 100mm to 125mm.

Laying of lime concrete shall be commenced from a corner of the roof and proceeded diagonally towards centre and other sides duly considering the slopes specified for effectively draining the rain-water towards the downtake points.

Lime concrete fillet for a minimum height of 150mm shall be provided all along the junction of the roof surface with the brick masonry wall/parapet/column projections. These shall then be finished on top with provision of clay terracing tiles/cement concrete tiles.

After the lime concrete is laid it shall be initially rammed with a rammer weighing not more than 2 Kg and the finish brought to the required evenness and slope. Alternatively, bamboo strips may be used for the initial ramming. Further consolidation shall be done using wooden THAPIES with rounded edges. The beating will normally have to be carried on for at least seven days until the THAPI makes no impression on the surface and rebounds readily from it when struck. Special care shall be taken to properly compact the lime concrete at its junction with parapet walls or column projections.

During compaction by hand-beating, the surface shall be sprinkled liberally with lime water (1 part of lime putty and 3 to 4 parts of water) and a small proportion of sugar solution for obtaining improved water-proofing quality of the lime concrete. On completion of beating, the mortar that comes on the top shall be smoothened with a trowel or float, if necessary, with the addition of sugar solution and lime putty. The sugar solution may be prepared in any one of the following ways as directed by the Engineer.

a) By mixing about 3 Kg of Jaggery and 1.5 Kg of BAEL fruit to 100 litres of water.

b) By mixing about 600 gm of KADUKAI (the dry nuts shall be broken to small pieces and allowed to soak in water), 200 gm of jaggery and 40 litres of water for 10 sq.m of work. This solution shall be brewed for about 12 to 24 hours and the resulting liquor decanted and used for the work.

The lime concrete after compaction shall be cured for a minimum period of seven days or until it hardens by covering with a thin layer of straw or hessian which shall be kept wet continuously.

Machine made flat terracing tiles shall be of the size and thickness as specified. Tiles shall be soaked in water for at least one hour before laying. Bedding for the tiles shall be 12mm thick in cement mortar 1:3. Tiles shall be laid, open jointed with 4 to 6 mm wide joints, flat on the mortar and lightly pressed and set to plane surface true to slope, using a trowel and wooden straight edge. They shall be laid with their longitudinal lines of joints truly parallel and generally at right angles to the direction of run-off gradient. Transverse joints in alternate rows shall come directly in line with each other. Transverse joints in adjacent courses shall break joints by atleast 50 mm. The joints shall be completely filled and flush pointed with cement mortar 1:2 mixed with water proofing compound as per manufacturer's instructions. Curing shall be carried out for a minimum period of seven days.

Finishing on top with cement concrete tiles or in-situ cement concrete floor topping shall be carried out in similar fashion as described for clay tiles in above the paragraph. Tiles to be used shall be supplied after the first machine grinding of the surface.

8.25.4 Measurement

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be for the plan area where the treatment is executed. No separate payment shall be made for the fillets.

8.25.5 Waterproofing of Roofs/Terraces etc.

8.25.5.1 Water proofing of Horizontal Surfaces

The waterproofing shall be applied as follows:

A coat of Blown Bitumen 85/25 shall be applied at the rate of 1.45 kg/sq.km

A roll of Modified Bituminous Membrane shall be unrolled over the primed surface and completely bonded to the substrate by pressing down evenly for the full width of the roll using a wooden roller. Torching shall be done, where recommended by the manufacturer and where directed by the Engineer-in-Charge, as the unrolling progresses.

The side overlaps shall be minimum 100 mm whereas the end overlaps shall be minimum 150 mm; both shall be bonded and sealed by flame torching.

Care shall be taken that the membrane is lapped with the treatment along the vertical surface and roof gutter treatment for at least 500 mm.

The membrane shall be properly overlapped/terminated at all openings, rainwater downtakes etc. to ensure that such junctions do not become sources of leakage.

Top of membrane finally shall be painted with antiglouse reflective paint.

8.25.5.2 Waterproofing of Vertical Surfaces at Roof Level and Gutters

The Water proofing shall be applied as described in (a) above.

Modified Bituminous membrane shall be unrolled and bonded to the substrate after applying a coat of bitumen and by pressing down evenly for the full width of the roll. Light torching shall be done to ensure complete bonding.

The membrane shall be overlapped with treatment for the horizontal surface by at least 500 mm.

The membrane shall be taken upto a pre-cut chase anchored and sealed.

8.25.6 Khurras and Rainwater Down Pipes

Down pipes shall be isolated from RCC work with 6 mm polyethylene foam fixed with adhesive (Araldite) and sealed with silicone sealant prior to laying membrane. A water proofing flashing composed of one layer of Hessian based self finished felt Type 3 Grade 1 and two layers of aluminium foil of 0.075 mm thickness shall be provided. This flashing shall be carried into the down take pipes for at least 150 mm and sealed with hot bitumen. The Contractor shall closely coordinate the work with the agency providing and fixing the rainwater down take pipes.

8.25.7 Testing

The treated area (flat and horizontal only) shall be tested by allowed water to stand on the treated areas to a depth of 150 mm for a minimum period of 72 hours.

The treated area (flat and horizontal) shall have continuous slope towards the rainwater outlets and no water shall pond any where on the surface.

8.26 Cement Plastering Work

8.26.1 Materials

The proportions of the cement mortar for plastering shall be 1:4 (one part of cement to four parts of sand). Cement and sand shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS standards. The quality and grading of sand for plastering shall conform to IS: 1542. The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the Engineer. If so desired by the Engineer sand shall be screened and washed to meet the Specifications. The mortar thus mixed shall be used as soon as possible preferably within 30 minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water this may be re- tempered by adding water as required to restore consistency but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement.

Any mortar which is partially set shall be rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances.

8.26.2 Workmanship

Preparation of surfaces and application of plaster finishes shall generally conform to the requirements specified in IS: 1661 and IS: 2402.

Plastering operations shall not be commenced until installation of all fittings and fixtures such as door/window panels, pipes, conduits etc. are completed.

All joints in masonry shall be raked as the work proceeds to a depth of 10mm/20mm for brick/stone masonry respectively with a tool made for the purpose when the mortar is still green. The masonry surface to be rendered shall be washed with clean water to remove all dirt, loose materials, etc., Concrete surfaces to be rendered shall be roughened suitably by hacking or bush hammering for proper adhesion of plaster and the surface shall be evenly wetted to provide the correct suction. The masonry surfaces should not be too wet but only damp at the time of plastering. The dampness shall be uniform to get uniform bond between the plaster and the masonry surface.

Interior plain faced plaster - This plaster shall be laid in a single coat of 13mm thickness. The mortar shall be dashed against the prepared surface with a trowel. The dashing of the coat shall be done using a strong whipping motion at right angles to the face of the wall or it may be applied with a plaster machine. The coat shall be trowelled hard and tight forcing it to surface depressions to obtain a permanent bond and finished to smooth surface. Interior plaster shall be carried out on jambs, lintel and sill faces, etc. as shown in the drawing and as directed by the Engineer.

Plain Faced Ceiling plaster - This plaster shall be applied in a single coat of 6mm thickness. Application of mortar shall be as stipulated in above paragraph.

Exterior plain faced plaster - This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 14mm thick. The rendering coat shall be applied as stipulated above except finishing it to a true and even surface and then lightly roughened by cross scratch lines to provide bond for the finishing coat. The rendering coat shall be cured for atleast two days and then allowed to dry. The second coat or finishing coat shall be 6 mm thick. Before application of the second coat, the rendering coat shall be evenly damped. The second coat shall be applied from top to bottom in one operation without joints and shall be finished leaving an even and uniform surface. The mortar proportions for the coats shall be as specified in the respective item of work. The finished plastering work shall be cured for atleast 7 days.

Interior plain faced plaster 20mm thick if specified for uneven faces of brick walls or for random/coursed rubble masonry walls shall be executed in 2 coats similar to the procedure stipulated in above paragraph.

Exterior Sand Faced Plaster- This plaster shall be applied in 2 coats. The first coat shall be approximately 14mm thick and the second coat shall be 6mm thick. These coats shall be applied as stipulated above. However, only approved quality white sand shall be used for the second coat and for the finishing work. Sand for the finishing work shall be coarse and of even size and shall be dashed against the surface and sponged. The mortar proportions for the first and second coats shall be as specified in the respective items of work.

Wherever more than 20mm thick plaster has been specified, which is intended for purposes of providing beading, bands, etc. this work shall be carried out in two or three coats as directed by the Engineer duly satisfying the requirements of curing each coat (rendering/floating) for a minimum period of 2 days and curing the finished work for atleast 7 days.

In the case of pebble faced finish plaster, pebbles of approved size and quality shall be dashed against the final coat while it is still green to obtain as far as possible a uniform pattern all as directed by the Engineer.

Where specified in the drawings, rectangular grooves of the dimensions indicated shall be provided in external plaster by means of timber battens when the plaster is still in green condition. Battens shall be carefully removed after the initial set of plaster and the broken edges and corners made good. All grooves shall be uniform in width and depth and shall be true to the lines and levels as per the drawings.

Curing of plaster shall be started as soon as the applied plaster has hardened sufficiently so as not to be damaged when watered. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days.

For waterproofing plaster, the Contractor shall provide the water-proofing admixture as specified in manufacturers instruction while preparing the cement mortar.

For external plaster, the plastering operations shall be commenced from the top floor and carried downwards. For internal plaster, the plastering operations for the walls shall commence at the top and carried downwards. Plastering shall be carried out to the full length of the wall or to natural breaking points like doors/windows etc. Ceiling plaster shall be completed first before commencing wall plastering.

Double scaffolding to be used shall be as specified in clause 8.2.2.

The finished plaster surface shall not show any deviation more than 4mm when checked with a straight edge of 2m length placed against the surface.

To overcome the possibility of development of cracks in the plastering work following measures shall be adopted.

a) Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.

b) Steel wire fabric shall be provided at the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage/thermal movement.

c) Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaces where discontinuity of the background exists.

8.26.3 Measurement

Measurement for plastering work shall be in sq.m correct to two places of decimal. Unless a separate item is provided for grooves, mouldings, etc., these works are deemed to be included in the unit rates quoted for plastering work. The quantity of work to be paid for under these items shall be calculated by taking the projected surface of the areas plastered after making necessary

deductions for openings for doors, windows, fan openings etc. The actual plaster work carried out on jambs/sills of windows, openings, etc. shall be measured for payment.

8.27 Cement Pointing

8.27.1 Materials

The cement mortar for pointing shall be in the proportion of 1:3 (one part of cement to three parts of fine sand). Sand shall conform to IS: 1542 and shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by Engineer and if so directed it shall be washed/screened to meet specification requirements.

8.27.2 Workmanship

Where pointing of joints in masonry work is specified, the joints shall be raked at least 15mm/20mm deep in brick/stone masonry respectively as the work proceeds when the mortar is still green.

Any dust/dirt in the raked joints shall be brushed out clean and the joints shall be washed with water. The joints shall be damp at the time of pointing. Mortar shall be filled into joints and well pressed with special steel trowels. The joints shall not be disturbed after it has once begun to set. The joints of the pointed work shall be neat. The lines shall be regular and uniform in breadth and the joints shall be raised, flat, sunk or 'V' as may be specified in the respective items of work. No false joints shall be allowed.

The work shall be kept moist for atleast 7 days after the pointing is completed. Whenever coloured pointing has to be done, the colouring pigment of the colour required shall be added to cement in such proportions as recommended by the manufacturer and as approved by the Engineer.

8.27.3 Measurement

The quantity of work to be paid for under this item shall be measured in sq.m. Correct to two places of decimal by taking the projected surface of the area pointed after making necessary deductions for openings, etc.

8.28 Metal Lath and Wire Fabric

8.28.1 Materials

Welded steel wire fabric shall conform to IS: 4948.

Expanded metal shall conform to IS: 412.

Galvanised wire mesh shall be of approved quality.

8.28.2 Workmanship

The type and details of the steel material to be used for metal lath plastering work and at the junctions of brick masonry/concrete before wall plastering shall be as specified in the respective items of work.

For metal lath plastering work, the weight of steel material shall be not less than 1.6 kg/sq.m.

Steel material for use at the junction of brick masonry/concrete shall have the mesh dimensions not greater than 50 mm.

Steel material shall be obtained in maximum lengths as manufactured to restrict joints to the minimum. Overlap at the joints shall be minimum 25 mm which shall be securely tied with wires of diameter not less than 1.25 mm at spacings not more than 100 mm for lath plastering work. Nailing to wall shall be at spacings not exceeding 200 mm. The material shall be straightened, cut and bent to shape if required for fixing as per the details indicated in the drawings.

8.28.3 Measurement

Measurement shall be in sq.m correct to two places of decimal for the type as specified in the respective items of work.

8.29 Water-Proofing Admixtures

Water-proofing admixture shall conform to the requirements of IS: 2645 and shall be of approved manufacture. The admixture shall not contain calcium chloride. The quantity of the admixture to be used for the works and method of mixing etc. shall be as per manufacturer's instructions and as directed by the Engineer.

8.30 Painting of Concrete, Masonry & Plastered Surfaces

8.30.1 Materials

Oil bound distemper shall conform to IS: 428. The primer shall be an alkali-resistant primer of the same manufacturer as that of the distemper.

Cement paint shall conform to IS: 5410. The primer shall be a thinned coat of cement paint.

Lead free acid, alkali and chlorine resisting paint shall conform to IS: 9862.

White wash shall be made from good quality fat lime conforming to IS: 712. It shall be slaked at site and mixed with water in the proportion of 5 litres of water to 1 kg of unslaked lime stirred well to make a thin cream. This shall be allowed to stand for a minimum period of one day and strained through a clean coarse cloth. Four kg of gum dissolved in hot water shall be added to each cum of cream. 1.30 kg of sodium chloride dissolved in hot water shall then be added per 10 kg of lime used for the white wash, making it ready for application.

Colour wash shall be made by addition of a suitable quantity of mineral pigment, not affected by lime, to the prepared white wash to obtain the shade/tint as approved by the Engineer.

All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the Engineer for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

8.30.2 Workmanship

Contractor shall obtain the approval of the Engineer regarding the readiness of the surfaces to receive the specified finish, before commencing the work on painting.

Painting of new surfaces shall be deferred as much as possible to allow for thorough drying of the sub- strata.

The surfaces to be treated shall be prepared by thoroughly brushing them free from dirt, mortar droppings and any loose foreign materials. Surfaces shall be free from oil, grease and efflorescence. Efflorescence shall be removed only by dry brushing of the growth. Cracks shall be filled with Gypsum. Workmanship of painting shall generally conform to IS: 2395.

Surfaces of doors, windows etc. shall be protected suitably to prevent paint finishes from splashing on them.

8.30.3 White Wash

The prepared surfaces shall be wetted and the finish applied by brushing. The operation for each coat shall consist of a stroke of the brush first given horizontally from the right and the other from the left and similarly, the subsequent stroke from bottom upwards and the other from top downwards, before the first coat dries. Each coat shall be allowed to dry before the next coat is applied. Minimum of 2 coats shall be applied unless otherwise specified. The dry surface shall present a uniform finish without any brush marks.

8.30.4 Colour Wash

Colour wash shall be applied in the same way as for white wash. A minimum of 2 coats shall be applied unless otherwise specified. The surface shall present a smooth and uniform finish without any streaks. The finished dry surface shall not show any signs of peeling/powdery and come off readily on the hand when rubbed.

8.30.5 Cement Paint

The prepared surfaces shall be wetted to control surface suction and to provide moisture to aid in proper curing of the paint. Cement paint shall be applied with a brush with stiff bristles. The primer coat shall be a thinned coat of cement paint. The quantity of thinner shall be as per manufacturer's instructions. The coats shall be vigorously scrubbed to work the paint into any voids for providing a continuous paint film free from pinholes for effective water proofing in addition to decoration. Cement paint shall be brushed in uniform thickness and the covering capacity for two coats on plastered surfaces shall be 3 to 4 kg/sq.m. A minimum of 2 coats of the same colour shall be applied. Atleast 24 hours shall be left after the first coat to become sufficiently hard before the second coat is applied. The painted surfaces shall be thoroughly cured by sprinkling with water using a fog spray at least 2 to 3 times a day. Curing shall commence after about 12 hours when the paint hardens. Curing shall be continued for atleast 2 days after the application of final coat. The operations for brushing each coat shall be as detailed above.

8.30.6 Oil bound Distemper

The prepared surfaces shall be dry and provided with one coat of alkali resistant primer by brushing. The surface shall be finished uniformly without leaving any brush marks and allowed to dry for atleast 48 hours. A minimum of two coats of oil bound distemper shall be applied, unless otherwise specified. The first coat shall be of a lighter tint. Atleast 24 hours shall be left after the first coat to become completely dry before the application of the second coat. Broad, stiff, double bristled distemper brushes shall be used for the work. The operations for brushing each coat shall be as detailed above.

8.30.7 Acid, Alkali Resisting Paint

A minimum of two coats of acid- and alkali-resistant paint shall be applied over the prepared, dry surfaces by brushing. Primer coat shall be as per manufacturer's instructions.

8.30.8 Plastic Emulsion Paint

The prepared surface shall be dry and provided with one coat of primer which shall be a thinned coat of emulsion paint. The quantity of thinner shall be as per manufacturer's instructions. The paint shall be laid on evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard for the first time over and then brushing alternately in opposite directions two or three times and then finally brushing lightly in a direction at right angles. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off constitutes one coat. The next coat shall be applied only after the first coat has dried and sufficiently become hard which normally takes about 2 to 3 hours. A minimum of 2 finishing coats of the same colour shall be applied unless otherwise specified. Paint may also be applied using rollers. The surface on finishing shall present a flat velvety smooth finish and uniform in shade without any patches.

8.30.9 Acrylic Emulsion Paint

Acrylic emulsion paint shall be applied in the same way as for plastic emulsion paint. A minimum of 2 finishing coats over one coat of primer shall be provided unless otherwise specified.

8.30.10 Measurement

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be for the areas as executed duly deducting for any openings etc. Rate quoted shall take into account the provision of necessary enabling works such as scaffolding, painter’s cradle etc.

8.31 Painting & Polishing of Wood Work

8.31.1 Materials

Wood primer shall conform to IS: 3536.

Filler shall conform to IS: 110.

Varnish shall conform to IS: 337.

French polish shall conform to IS: 348.

Synthetic enamel paint shall conform to IS: 2932.

All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the Employer’s Representative for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

8.31.2 Workmanship

The type of finish to be provided for woodwork of painting or polishing, the number of coats, etc. shall be as specified in the respective items of work to be prepared by the Contractor.

Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

Painting shall be either by brushing or spraying. Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirements of IS: 2338 (Part I).

All the wood surfaces to be painted shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it across the grains and dusted off. Wood primer coat shall then be applied uniformly by brushing. The number of primer coats shall be as specified in the item of work to be prepared by the Contractor. Any slight irregularities of the surface shall then be made- up by applying an optimum coat of filler conforming to IS: 110 and rubbed down with an abrasive paper for obtaining a smooth surface for the undercoat of synthetic enamel paint conforming to IS:2932. Paint shall be applied by brushing evenly and smoothly by means of crossing and laying off in the direction of the grain of wood. After drying, the coat shall be carefully rubbed down using very fine grade of sand paper and wiped clean before the next coat is applied. Atleast 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the Employer's Representative. The number of coats of paint to be applied shall be as specified in the item of work to be prepared by the Contractor.

All the wood surfaces to be provided with clear finishes shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it in the direction of the grains and dusted off. Any slight irregularities of the surface shall be made up by applying an optimum coat of transparent liquid filler and rubbed down with an abrasive paper for obtaining a smooth surface. All dust and dirt shall be thoroughly removed. Over this prepared surface, varnish conforming to IS:337 shall be applied by brushing. Varnish should not be retouched once it has begun to set. Staining if required shall be provided as directed by the Employer's Representative. When two coats of varnish is specified, the first coat should be a hard-drying undercoat or flatting varnish which shall be allowed to dry hard before applying the finishing coat. The number of coats to be applied shall be as specified. For works where clear finish of French polish is specified the prepared surfaces of wood shall be applied with the polish using a pad of woolen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles to give an even finish over the entire area. The surface shall be allowed to dry before applying the next coat. Finishing shall be carried out using a fresh clean cloth over the pad, slight dampening with methylated spirit and rubbing lightly and quickly in circular motions. The finished surface shall have a uniform texture and high gloss. The number of coats to be applied shall be as specified.

8.32 Painting of Steel Work

8.32.1 Materials

Red-oxide – zinc chrome primer shall conform to IS: 2074.

Synthetic enamel paint shall conform to IS: 2932.

Aluminium paint shall conform to IS: 2339.

All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the Employer's Representative for the brand of manufacture and the colour/shade. All the materials shall be brought to the site in sealed containers.

8.32.2 Workmanship

Painting work shall be carried out only on thoroughly dry surfaces. Painting shall be applied either by brushing or by spraying. Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirement of IS: 1477 (Part 2).

The type of paint, number of coats etc. shall be as specified in the respective items of work.

Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

All the surfaces shall be thoroughly cleaned of oil, grease, dirt, rust and scale. The methods to be adopted using solvents, wire brushing, power tool cleaning etc., shall be as per IS: 1477 (Part – I) and as indicated in the item of work.

It is essential to ensure that immediately after preparation of the surfaces, the first coat of red oxide-zinc chrome primer shall be applied by brushing and working it well to ensure a continuous film without holidays. After the first coat becomes hard dry, a second coat of primer shall be applied by brushing to obtain a film free from `holidays'.

After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of synthetic enamel paint of optimum thickness shall be applied by brushing with minimum of brush marks. The coat shall be allowed to hard-dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

The first finishing coat of paint shall be applied by brushing and allowed to hard-dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing.

Atleast 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the Employer's Representative.

8.33 Flashing

8.33.1 Materials

Anodised Aluminium sheets shall be 1.00mm thick with anodic film thickness of 0.025 mm.

Galvanised mild steel sheets shall be 1.00mm thick with zinc coating of 800 gms/sq.m.

Bitumen felt shall be either Hessian base self finished bitumen felt Type-3 Grade I conforming to IS:1322 or glass fibre base self finished felt Type-2 Grade 1 conforming to IS:7193.

8.33.2 Workmanship

The type of the flashing and method of fixing shall be as specified.

Flashing shall be of the correct shape and size as indicated in the construction drawings and they shall be properly fixed to ensure their effectiveness.

Flashing shall be of long lengths so as to provide minimum number of joints. The minimum overlap at joints shall be 100mm.

Fixing of the flashing shall be either by bolting with bitumen washers or by tucking into the groove 75 mm wide x 65 mm deep in masonry/concrete along with cement mortar 1:4 filletting as indicated in the Drawings. Curing of the mortar shall be carried out for a minimum period of 4 days.

Bitumen felt flashing of the type as specified shall be provided with 2 coats of bituminous paint at the rate of 0.10 litre/sq.m after the installation.

8.33.3 Measurement

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be for the actual area of the flashing material provided and the rate shall include for all the incidental works of bending to shape and fixing details as per the construction drawings.

8.34 Thermal Insulation for Ceiling

Thermal insulation shall be "Thermocole" TF type or similar approved or resin-bonded fiberglass boards.

8.34.1 Fixing

8.34.2 "Thermocole" Boards

Soffit of R.C. slab shall be thoroughly cleaned with a wire brush, and 85/25 industrial grade hot bitumen conforming to IS: 702 shall be applied uniformly over the surface at the rate of 1.5 Kg/m^2.

Thermocole boards (T.F. variety) of 50mm thickness shall be stuck by means of the same grade of hot bitumen.

The boards shall be further secured with screws, washers and plugs.

The joints of the boards shall be sealed with bitumen.

8.34.3 Fibre Glass Boards

Timber pegs 50mm x 50mm x 50mm shall be fixed to the slab at 600mm centres with 6mm x 65mm long wood screws. 20 gauge G.I. lacing wire shall be tied to the pegs.

`Crown' 200 fiberglass boards 50mm thick shall be stuck to the pegs with CPRX compound or any other suitable adhesive and be held in position by the 20 gauge G.I. lacing wires.

The insulation boards shall be covered with 20mm – 24 gauge hexagonal G.I. chicken wire mesh, nailed to the timber pegs and 30 gauge aluminium sheets shall be fixed over the chicken wire mesh with 50mm overlap and secured to the timer pegs by screws.

If the insulation is specified to rest on top of the false ceiling, it shall be properly installed and anchored to the framework. In case additional battens are required for proper installation, Contractor shall include its cost in the rate for insulation.

8.34.4 Measurement

The net superficial area of the insulation shall be measured and paid for.

8.35 Plaster of Paris Board False Ceiling

8.35.1 Plaster of Paris Boards

The plaster of paris boards to be used in the false ceiling shall be of an approved manufacture or manufactured at site by methods and materials approved by Engineer.

The plaster of paris shall be of the calcium-sulphate hemi-hydrate variety and shall contain not less than 35 percent sulphur trioxide and other requirements as per IS:2547 (Part I). However, its fineness shall be such that the residue, after drying, and sieving on I.S. sieve designation 3.35mm for 5 minutes shall not be more than 1 percent by weight. Initial setting time shall not be less than 13 minutes. The average compressive strength of plaster determined by testing 5 cm cubes 24 hours after removal from moulds and drying in an oven at 40 Deg. C till the weight of the cubes is constant, shall not be less than 84 kg per sq.cm.

The plaster of paris boards reinforced with hessian cloth or coir shall be prepared in suitable sizes as shown on the drawings or as directed by the Engineer. Wooden forms of height equal to the thickness of boards shall be placed on truly level and smooth surface such as a glass sheet. The edges of the boards shall be truly square. The glass sheet or surface on which form is kept and the form sides shall be given a thin coat of non-staining oil to facilitate the easy removal of the board. Plaster of paris shall be evenly spread into the form upto about half the depth and hessian cloth or coir shall be pressed over the plaster of paris layer. The weight of hessian cloth or coir in the board shall be 250 gm per sq.m. The ends of the hessian/coir reinforcement shall be turned over at all edges to form a double layer for a width of 50mm. The hessian cloth shall be of an open web texture so as to allow the plaster below and above to intermix with each other and form an integral board. The form shall then be filled with plaster of paris which shall be uniform pressed and then wire cut to an even and smooth surface. The board shall then be allowed to set initially for an hour or so and then removed from the form and allowed to dry and harden for about a week. The board after drying and hardening shall give a ringing sound when struck. The boards shall be true and exact to shape and size and the exposed face shall be truly plane and smooth.

The size of boards shall generally be 600mm x 600 mm x 12 mm thick. Boards shall be kept dry in transit and stored flat in a clean dry place and shall not be exposed to moisture. The boards shall always be carried on edges.

8.35.2 Metal Framework

The metal frame work may be made of sections of light metal, such as anodised aluminium, mild steel or as shown on the drawings. The shape of cross-section shall be such as to facilitate proper suspension and proper fixing of the ceiling boards covering them and shall be structurally sound and rigid.

8.36 Construction

Contractor shall ensure that the frame to support the ceiling is designed for structural strength and the sizes, weight and strength of ceiling boards to be fixed and other loads due to live load, air-conditioning ducts, grills, electrical wiring and lighting fixtures, thermal insulation, etc. as shown on the drawings. Contractor shall also submit a detailed drawing to show the grid work, sizes of grid members, method of suspension, position of openings for air-conditioning and lighting, access doors, etc.

The false ceiling grid work shall be carried out as per the approved drawings or as directed by Engineer. In case of timber grid work, the grid work shall consist of teak wood runners of minimum size 60mm deep x 40mm wide along one direction at 1.2m centre to centre and secondary runners of size 50mm deep x 40 mm wide at 60mm centre to centre perpendicular to the main runners.

The metal frame work when it is anodised aluminium false ceiling grid system shall consist of aluminium main member of special T-Profile of 38mm x 38mm x 1.5mm thick, interlocking with each other to form frames of various sizes, 600mm x 600 mm or as shown on the drawing. The main members shall be suspended from the roof structures by means of steel hangers as described for timber frame work and supported at the walls by means of anodised aluminium wall angles.

In the case of timber frame work, all the edges of the plaster of paris board shall be fixed to frame members by means of counter sunk and rustless screws of 2.74 mm size, 40mm long at a spacing of 100mm to 150 mm c/c and 12mm from the edge of the board. Holes for screws shall be drilled and screws slightly countersunk into the boards. The boards shall be fixed to wooden framework with a joint clearance of about 3mm. The joints shall always be in perfect line and plane.

In case of aluminium grid system, boards shall be just placed into the frames formed by the main `T' members and the cross members fitted with the clips for locking boards. Contractor shall take utmost care so as not to force the boards in position and a slight gap shall be provided so as not to make a tight joint. The boards shall be cut with a saw, if required, to any shape and size.

As the work of false ceiling may be inter-connected with the work of air-conditioning ducts and lighting, Contractor shall fully co-operate with the other agencies entrusted with the above work, who may be working simultaneously. Contractor shall provide necessary openings in the false ceiling work for air-conditioning, lighting and other fixtures. Additional framing, if required, for the above opening shall also be provided at no extra cost to the Employer. Removable or hinged type inspection or access trap doors shall be provided at locations specified by the Engineer.

8.36.1 Finishing

It is essential that false ceiling work should be firm and in perfect line and level and all boards free from distortion, bulge, and other defects. All defective boards and other material shall be removed from site immediately and replaced, and ceiling restored to original finish to the satisfaction of Engineer.

The workmanship shall be of highest order and all joinery work for timber work shall be in the best workmanship manner. The joints for aluminium frame work shall be of inter-locking type so that when the cross member is in place, it cannot be lifted out.

The countersunk heads of screws and all joints shall be filled with plaster of paris and finished smooth. After filling the joints, a thick skin of the finishing material shall be spread about 50mm wide on either side of the joint and on to it shall be trowelled dry a reinforcing scrim cloth about 10mm wide. If metal scrim is used, a stiffer plaster will be necessary to enable the trowelling of the scrim down to the board.

8.36.2 Fire Stopping

In case of fire protective ceilings, fire resisting barriers at suitable intervals shall be provided. These shall completely close the gap between the false ceiling and soffit of the structural slab. The material of the barrier shall be as indicated by Engineer (Reference may be made to the British Standards Institutions CP 290: Code of Practice for suspended ceiling and lining of dry construction using metal fixing system, `for guidance).

8.36.3 Measurement and Payment

The superficial area of false ceiling shall be measured and paid for at the unit rate less deductions, if any. Openings in false ceiling which are less than 0.4 sq.m. in area shall not be deducted for the purpose of payment.

The quoted rates shall include supply, delivery and erection of all materials for covering the ceiling, frame work suspenders or hangers, anti-termite treatment making openings in false ceiling, extra frame work required for the openings, supporting the main members on masonry walls, levelling and finishing complete.

Where moulding or beading is specified, it shall be as per details shown in drawings and shall be measured in running metres and paid for separately.

Where fire barriers are specified, they shall be as per details shown in drawings and as directed and shall be measured in square metres and paid for separately.

8.37 False or Cavity Floor

8.37.1 Frame Work

The false floor shall consist of a framework of suitable structural member designed to carry the loads specified. This frame work shall be supported on suitably designed stools placed at 600mm centre to centre in both directions. The stools shall consist of a mild steel base plate with a mild steel stud having adjustable lock nut and coupling at the centre and another mild steel plate at top serving as a prophead. The above framework shall be suitably designed to accommodate 35mm thick, 600mm square panels. The base plate shall be fixed to the reinforced concrete floor with an approved adhesive compound or with 4 Nos. 6mm dia. anchor fasteners. Bedding of 1:2 or richer cement sand mortar shall be provided locally under the base plates of stools to provide a level surface.

The prophead shall be provided with mild steel lugs welded on top and each placed perpendicular to the other for proper positioning and supporting the main and cross members. The stools shall be capable of adjustment to accommodate concrete floor level irregularities upto plus or minus 15mm. The framing members shall be completely removable and shall remain in position without screwing or bolting to the propheads. All steel framework including steel stools shall be given a coat of zinc chromate primer and two coats of enamel paint of approved colour and shade.

8.37.2 Floor Panels

The floor panels shall be made of 600mm x 600mm x 35 mm thick medium density unveneered/ non-prelaminated teak wood particle boards having a density of not more than 800 kg/cum bonded with boiling water proof phenol formaldehyde synthetic resin and shall be of fire resistant, termite resistant and moisture proof quality, generally conforming to IS: 3087- specification for wood particle boards (Medium Density) for general purposes.

The thermal conductivity of the boards shall not exceed 0.12 k Cal/hr/sq.m/deg./C/m.

The panel size given above may be suitably modified near electrical panel/equipment and also to suit room dimensions with panel size not more than 600mm under any circumstances. Exposed 2mm thick vinyl edging shall be provided on all edges of individual panels. Each panel shall be given a coat or primer and two coats of approved fire-resistant paint from underside.

The particle boards shall be faced with 600mm x 600 mm x 2mm thick approved make flooring tiles conforming to IS:3462 and of approved colour and shade. The completed panel shall be completely removable and shall remain in position without screwing or bolting to the supporting framework. Each floor panel shall be marked on the inner side with stickers for easy identification and reassembly whenever required.

Suitable backing material shall be provided on the underside of the particle board to prevent warping and / or to cater to specified loading.

Floor panels made of 600mm x 600mm x 35 mm thick Steel Cementitious laminated panels can also be used with suitable supporting system.

Suitable removable covers shall be provided to serve as outlets for the cables.

8.37.3 Finished Height of False Flooring

The finished height from top of reinforced concrete floor to the finished floor surface of false/cavity floor shall be as specified or as shown on drawings.

8.37.4 Ramps and Steps

Ramps and steps shall be provided as shown on the Engineer's drawing and as directed by the Engineer without any extra cost to the Employer.

8.37.5 Imposed Loading

The finished floor shall be capable of supporting uniformly distributed loads of 500 to 1000 Kg. per sq.metre of floor area as specified in data sheet. A point load of 450 Kg on 600 sq.mm on any part of the panel or a line load of 725 Kg on 100mm strip across the panel length shall not result in a deflection greater than 2.5mm.

8.37.6 Finish

The finished floor shall be true to lines and levels and present a neat flush surface.

8.37.7 General

Supply shall be made by a specialist supplier who is to be approved by Engineer. Supplier shall prepare and submit a layout drawing for false floor giving all details including supporting system for approval. If so called for, supplier shall also submit his calculations for the supporting system

with all relevant data assumed, to the Engineer for his approval. Work shall be carried out on approved drawings only.

8.37.8 Measurement

The superficial area of false floor shall be measured and paid for at the quoted unit rate.

8.38 Vendor Drawing

Vendor shall prepare and submit a layout drawing for false floor giving all details including supporting system for approval. If so called for, vendor shall also submit his calculations for the supporting system with all relevant data assumed, to the Employer's Representative for his approval. Work shall be carried out on approved drawings only.

8.39 Fire Proof Doors

8.39.1 Material and Workmanship

The design of fire proof doors and the materials to be used in their fabrication have to be such that they shall be capable of providing the effective barrier to the spread of fire. The materials, fabrication and erection of fire proof doors shall confirm to IS: 3614 (Part – I). The fire proof doors shall be obtained from an approved manufacturer. Specific approval for such purchase shall be obtained before hand. Sample approval shall also be obtained from testing authority as per the standard IS: 3614 (Part – 2) for the specified degree of fire rating in hours. All fire proof doors shall have specified sizes and confirm to the description in the respective items of work.

Fire proof door shutters shall be of zinc coated weldable steel (confirming to BS: 6687) or stainless steel (conforming to IS: 304) sheet (18G minimum) fixed in a frame work of rolled channel. The shutter shall consist of an insulating material like mineral wool in required thickness to satisfy the specified fire rating. Normally the thickness of door shutter shall not be less than 35mm for two-hour fire rating and 46 mm for four-hour fire rating.

The shutter with the required insulating material shall be mounted on angle iron frame or the special made frame from zinc coated (16G minimum) weldable steel sheet. The shutter shall be fixed to frame by means of suitable hinges and shall have a three-way latching system. All the doors shall be provided with a coat of primer and one coat of synthetic enamel paint to attain the specified fire rating. All other accessories like hinges, door lock, hold fasts, etc. shall be provided as approved by TAC (Tariff Advisory Committee). All these accessories shall be compatible with the material used for door and shutter.

8.40 Hand Rails

All hand railing shall be provided with Aluminum Extrusion tubes having alloy AA6082 Temper T6 or AA 6063 T6 with an ultimate tensile strength of at least 207 MPa and yield strength of at least 172 MPa. The minimum height of hand railing shall be 1m and maximum spacing of verticals shall be 1.5 m- Number of horizontal rails shall be 3 with a 100mm x 2.5mm toe plate at the bottom.

Top Rail shall be from 32NB (42.16 mm OD) tube of schedule 40(3.50mm thk), while 2 no of mid rail shall be of 25NB (33.4mm OD) Schedule 40 tube. Post tube shall be 32NB (42.16mm

OD) Schedule 80 (4.80mm thk min). Toe guard of min 100mm height & having sufficient rigidity extruded out of min 2.5mm Thk alloy AA 6063 Temper T6.

welding not allowed for fabrication of handrails. Assembly and fabrication of Handrail shall be done by using Structural Fittings, manufactured from Aluminium Alloy 356/LM 25 with heat treatment (min UTS of alloy -280 N/mm2) confirming to ASTM B 108, ASTM B 26/ BS 1490. Aluminium Structural fittings shall be dynamically tested for permissible deflections while applying 74 kg / Linear Meter of UDL & 90 kg point load as per methodology mentioned in ASTM E 935.

Handrail shall be fixed on RCC surface with Mechanical or Chemical Anchor fasteners and shall be of SS or HDG and all fittings and pipes shall be prefinished as per IS 1868. The drawings to be submitted to the engineer for approval.

End of Chapter-8

CHAPTER 9

WELL SINKING

CHAPTER 9

WELL SINKING

9.1 General

Well sinking shall be proposed for Wetwell, in water logged conditions or water table near FGL.

9.2 Earthwork in Excavation

The earthwork shall be in accordance with chapter 3. The safety measures to be taken for excavations for open foundations shall be as per guidance laid down in IS 3764.

9.3 Well Sinking

The Construction and sinking of well shall in general follow provisions of IRC 78-2014- Section VII – Foundations and substructure. The latest editions of this code of practice including all applicable official amendments and revision shall be followed. In case of discrepancy between this specification and that referred in code, the specifications will govern.

9.3.1 Setting Out

Necessary reference points shall be fixed, away from the zone of blow-ups or possible settlements resulting from well sinking operations. These reference points shall be connected to the permanent stations with the base line on the banks. The centre of the individual wells shall be marked with reference to these stations.

9.3.2 Equipment

The following equipments are generally used for the work

(a) Crane with grab buckets - capacity 0.5 to 2.0 cum
(b) Chisels of appropriate sizes
(c) Aqua header for cutting rocky strata
(d) Diving helmets and accessories
(e) Equipment for concrete production, transportation, placing & compaction

9.3.3 Cutting Edge

The mild steel cutting edge shall be made from structural steel section with weight not less than 40 kg/m length and properly anchored into the well curb. The parts of the cutting edge shall be erected on level, firm ground. Temporary support shall be provided to facilitate the erection and maintenance of the assembly in its true shape. The fabrication may be carried out in the shop or at site. Steel sections shall not be heated and forced into shape. However, “V” cuts may be made in the horizontal portion, uniformly throughout the length, to facilitate cold bending. After bending such ‘V’ cuts should be closed by welding. Joints in the lengths of structural sections, unless otherwise specified shall be fillet welded using single cover plate to ensure the requisite strength of the original section. The cutting edge must be suitably stiffened

using plate stiffeners spaced at not more than 1.5m c/c along the periphery of cutting edge. The adequacy of the strength and the efficiency of performance of cutting-edge shall be specifically checked by the Contractor and necessary alterations made if required at his own responsibility. The weight of stiffeners shall not be considered in the weight of the cutting edge.

9.3.4 Well Curb

Well curb shall be of cast-in-situ concrete. The outer face of the curb shall be vertical. The bottom ends of vertical bond rods of steining shall be fixed securely to the cutting edge with check nuts or by welds. The form work on the outer face of the curb may be removed within 24 hrs after concreting. The formwork of the inner face shall be removed after 72 hrs. All the concreting in the well curb shall be done in one continuous operation. The curbs should be cast truly in position, and if construction of any cofferdam is required, it shall be done by the Contractor at his own cost.

9.4 Well Steining

The dimensions, shape, concrete strength and reinforcements of the well shall strictly conform to those shown in the drawings. The form work shall preferably be of M.S. sheets shaped and stiffened suitably. In case timber forms are used, they shall be lined with plywood or M.S. sheets.

Steining built in the first lift above the well curb shall not be more than 2 meters. For stability, the first lift of steining shall be cast only after partially sinking the curb. Concreting of steining may be carried out in subsequent lifts of about 2 meters. Attempts should be made to minimise the number of construction joints. The construction joint details shall be as shown in the drawing, and the receiving surfaces of the construction joint shall be thoroughly cleaned and prepared using air and water jets before the next lift is poured. The concreting layers shall be limited to about 450 mm restricting the free fall of concrete to not more than 2 m. Laitance formed at the top surface of a lift shall be removed to expose coarse aggregates before setting of concrete at the proposed construction joint. To the extent possible, construction joints shall not be located at the site of laps in the vertical steining bars.

The steining of the well shall be built in one straight line from bottom to top such that if the well is tilted, the next lift of steining will be aligned in the direction of the tilt. The work will be checked carefully with the aid of straight edges of lengths approved by the Engineer. Plumb bob or spirit level shall not be used for alignment. After the sinking of a stage is complete, any damaged portions of the steining at the top of the previous stage shall be properly repaired before constructing the next stage.

The height of steining shall be calibrated by making at least four gauges (preferably in direction along centre line of bridge and in a direction normal to the centre line of bridge) distributed equally on the outer periphery of the well each in the form of a 100 mm wide strip painted (preferably red colour) on the well, with every half a meter mark shown in black paint (mark thickness shall be 5mm). The gauges shall start with zero at the bottom of the cutting edge. Marking of the gauges shall be done carefully with a steel tape.

After reaching the founding level, the well steining shall be inspected to check for any damage or cracks. The Engineer will direct and the Contractor shall execute the remedial measures before acceptance of the well steining. If the well cannot be accepted despite any remedial measures, it shall be rejected.

Sinking of well should not be started till the steining has cured for at least 48 hours. The curing of well shall be continued upto 14 days from the day of concreting. Curing can be achieved through the use of water or through any approved curing compound.

Any honeycombed portion and leakage observed in the steining shall be repaired at the Contractor's own cost to the satisfaction of the Engineer.

9.4.1 Bottom Plug

The concrete mix shall be designed (in dry condition) to attain the concrete strength as mentioned in drawing, and shall contain 10% more cement content than that required for the same mix placed dry, to cater for under water concreting. However, the total cement content shall not be less than 360 kg/cum of concrete with a slump in the range of 150 mm to 200 mm. Admixture may be added to concrete to impart the required strength. The water cement ratio shall not exceed 0.5 and the slump of concrete shall be minimum 150mm. The diameter of tremie pipe shall not be less than 200 mm.

Concrete for the bottom plug shall be laid by Tremie pipe method. Tremie concrete once started shall be continued without interruption for full concreting in the bottom plug. Before commencing plugging, all loose material from the bottom of the well shall be removed and the inside faces cleaned thoroughly.

Concreting shall be done in one continuous operation till the dredge hole is filled upto the required height and thereafter sounding shall be taken to ensure that the concrete has been laid to the required height.

Least disturbance shall be caused to the water inside the well while laying concrete in the bottom plug and concrete shall not be disturbed in any way for atleast 14 days. To check any rise in the level of bottom plug, soundings should be taken at the close of concreting and once every day for the subsequent 3 days.

The soundness of bottom plug should be tested by de-watering the well by 5 meters below the surrounding water level and checking the rise of water. The rate of rise shall preferably be less than 10 cm/h. In case the rate is higher, remedial measures as directed by the Engineer should be taken by the Contractor at his own cost. The depth of the sump below the cutting for bottom plugging shall be 1/6th the diameter of the well. The Contractor shall take permission from Engineer before commencing the bottom plug. All necessary inspections like study of strata at the founding level, tilt, shift, etc. shall be communicated to the Engineer before bottom plugging. If any leakage of water is found, then necessary grouting of the plug and the junction of the well to control the same shall be carried out by the Contractor at no extra cost.

9.4.2 Sand Filling

Sand filling should be commenced after 14 days of laying the bottom plug. The height of bottom plug shall be rectified before starting sand filling. The sand should be clean and free from earth, clay, clods, roots, boulders, shingles etc. and should be backfilled in layers and consolidated by flooding.

9.4.3 Well Cap

The form work for the well cap should be prepared conforming to the shape of the well cap; concreting should be carried out in dry conditions. The bond rods of steining shall be properly anchored into the well cap.

9.5 Sinking of Well

Generally, the cutting edge is fabricated and connected to the concrete well curb. On top of the well curb, adequate height of well steining is cast and the process of sinking is carried out. After a portion of the well has been sunk, another height of well steining is cast on top of the previous section and further sinking carried out. The process is continued until the bottom level of the cutting edge reaches the foundation level.

The sinking of the well with use of kentledge shall be commenced only after the steining has been cured for at least 48 hrs. The well should not be placed in a pre-dredged hole. The sinking of the well shall be facilitated by excavating material uniformly from inside the dredge hole. Use of water jetting & divers may be adopted for sinking of well through harder strata with prior approval of the Engineer. The de-watering of well should not be used as a means for sinking of well. Contractor should take necessary precautions to avoid sand blows and he should be prepared at any point of time to tackle the sand blow problem, in case of any occurrence at no extra cost.

In the process of normal sinking any suitable method other than pneumatic sinking as necessary may be adopted. However, no claim due to any confirmations such as boulders, logs of trees met with during sinking or due to any other difficulty experienced in this process shall be entertained. The method to be adopted for sinking of well shall be approved by Engineer. For any change in method of sinking the Contractor shall obtain written permission from the Engineer-in-charge. During the operation of sinking of wells, the strata penetrated through and the behaviour of the well shall be reported to the Engineer. The Engineer's decision on any matter pertaining to sinking shall be final and binding on the Contractor.

As the dredging is in progress, soil samples for the study of soil parameters should be collected for every meter depth and the sample should be preserved as per the standard approved practice by the Contractor at no extra cost. The depth of sump in well at any level should not be more than one metre. Further the depth of sinking of well for a particular stage shall be restricted to 1 metre to avoid the sudden sinking of well i.e., jumping of well. A record of depth of dredging from the original bed level should be maintained right from the commencement of sinking of well.

If the well is sunk beyond the specified founding level without prior approval from the Engineer for any reason, the Contractor will not be entitled to any additional costs. In the event that the top of the well exceeds the required level due to unavoidable circumstances, it shall be the Contractor's responsibility to dismantle that portion of the work at their own cost. However, the matter should be discussed with the Engineer before any work in this regard is carried out.

9.5.1 Sinking History

The sinking history of well should be maintained in the format given in Appendix 1200/I of "Ministry of Road Transport & Highways - Roads & Bridges".

9.5.2 Use of Kentledge as Sinking Load

Kentledge shall be placed in an orderly and safe manner on the loading platform, ensuring it does not interfere with the excavation of material from inside the dredge hole and does not damage the steining of the well in any way. When tilts are present or there is a danger of well developing a tilt, the position of the load shall be regulated in such a manner as to provide greater sinking effort on the higher side of well.

9.5.3 Use of Divers

Use of divers may be made both for sinking purpose like removal of obstruction, excavation etc and for inspection. All safety precautions shall be taken as per applicable safety code for sinking with divers or any statutory regulations in force. Only persons trained for the diving operation shall be employed and shall be certified to be fit for diving by an approved doctor.

The diving and other equipment shall be of acceptable standard and certified to this effect by an approved independent agency. Arrangements for an ample supply of low-pressure, clean, cool air shall be ensured through an armored, flexible hose pipe. A standby compressor plant shall be provided in case of breakdown. All expenses incurred in use of divers, precautionary measures to be taken, casualties etc., will be at the Contractor's risk and own cost.

9.6 Precautions during Sinking

In case wells have to be sunk close to each other and clear distance between them is not greater than the diameter of well; sinking shall be taken up on all wells and they shall be sunk alternatively so that sinking of wells proceeds uniformly. Simultaneous and even dredging shall be carried out in wells in such a manner that the difference in the levels of the sump and cutting edge in the adjacent wells does not exceed half the clear gap between them. Preferably plugging of the wells close to each other can be done together.

Bore chart shall be referred to constantly during sinking for taking adequate care while piercing different types of strata. The type of soil as obtained during the well sinking should be compared with bore chart so as to take prompt decisions.

Before seasonal floods all wells sinking of which is in progress shall be sunk to sufficient depths below the designed scour level. Further they shall be temporarily filled and plugged so

that they do not suffer any tilt or shift during the floods. The Contractor can ask for any details related to hydraulics like HFL, LWL, scour depth etc., so as to plan his work suitably. Any losses incurred due to floods etc., by the Contractor due to improper planning of his work will be under Contractor's responsibility. No extra payment will be entertained in this regard.

All necessary precautions shall be taken against any possible damage to the existing foundations, prior to commencement of dredging from inside the well.

The dredged material shall not be allowed to accumulate over the well. It shall be dumped on the downstream and spread as far away as possible. In case the river stream flows along one edge of the well being sunk, the dredged material shall not be dumped on the dry side of the bank, but on the side on which the river current flows.

Very deep sump shall not be made below the well curb, as it entails risk of jumping (sudden sinking) of the well. The depth of sump shall be generally limited to $1/6^{th}$ of the outer diameter or 1m which ever is less.

In case a well sinks suddenly with a jerk, the steining of the well shall be examined to the satisfaction of the engineer to see that no damage has occurred to it.

De-watering shall be avoided if sand blows are expected. Any equipment and men working inside the well shall be brought out of the well as soon as there are any indications of a sand blow.

9.6.1 Tilts and Shifts

The tilt of any well shall not exceed 1 (horizontal) in 80 (vertical), and the shift at the well base shall not exceed 150mm in any resultant direction. Tilt's and shifts shall be carefully checked and recorded in the format given in Appendix 1207. of "Ministry of Road Transport & Highways - Roads & Bridges" regularly during sinking operations. For the purpose of measuring the tilts along the two axes of the bridge, the reduced level of the marks painted on the surface of the steeling of the well shall be taken. For the determination of the shift, the locations of the ends of the two diameters shall be precisely measured along the two axes, about fixed reference points.

The check for the occurrence of tilt should be made every day before the commencement of the work, and the readings/ findings should be properly recorded and maintained. The check for shift shall be done for every 1.5m of sinking of well. These recordings shall also be properly maintained.

Whenever any tilt is noticed, adequate preventive measures like placing eccentric kentledge, pulling, strutting, anchoring or dredging unevenly and depositing dredge material unequally, putting obstacles below cutting edge, water jetting etc. shall be adopted before any further sinking. After rectification, the dredging shall be uniform, and the dredged material shall be spread out uniformly. A pair of wells close to each other i.e., where clear distance between well is not greater than the diameter of well, they have tendency to come closer while sinking. Timber struts may be introduced in between the stonework of these wells to prevent tilting.

In the event of a well developing tilt or shift beyond the specified permissible values, the Contractor shall have to carry out, at his own cost, suitable remedial measures to the satisfaction of the Engineer, to bring the tilt and shift within the permissible values, as for as practicable.

If the resultant tilt and /or shift of any well exceed the specified permissible values, the well so sunk shall be regarded as not conforming to specification and a sub-standard work. Generally, it should not exceed 1 in 50 and 300 mm respectively. The Engineer in his sole discretion, may consider accepting such a well, provided the calculations for foundation pressure and steining stresses, accounting for the actual tilt and shift furnished by the Contractor show that well is safe. Any remedial measures required to bring the stresses within permissible values (such as increase in the dimension of the well cap, provision of dummy weights on the well cap) shall be carried out by the Contractor without claiming for any extra cost.

In case the Engineer, in his discretion rejects the well, the Contractor shall dismantle the rejected well to the extent directed by Engineer and remove the debris. Further the Contractor shall at his own risk and expense complete the bridge with modifications acceptable to the Engineer. The wells which are not conforming to the specified limits of tilts and shifts, if accepted for one or other reasons will be penalised in the form of lump-sum deductions per meter length of well which will be at the discretion of Engineer.

9.6.2 Seating of Well

The well shall be uniformly seated at the founding strata. After the well has been evenly seated on good hard rock, arrangements shall be made to facilitate proper inspection in dry and visible conditions before the bottom plug is laid. The founding levels shown in the drawings are purely based on the data available from geo-technical investigations. The Engineer on inspection will decide upon any modifications that may be required to meet the structural aspects. The bottom plugging shall be commenced only after this inspection and concurrence from Engineer.

9.6.3 Tolerances for Well Steining and Well Cap

The permissible tolerances are as follow:

(a)	Variation in dimension	:	+ 50mm - 10mm
(b)	Misplacement from specified position	:	15mm
(c)	Surface Irregularities measured with 3m straight edge	:	5mm
(d)	Variation of levels at the top	:	± 25mm

9.6.4 Measurement for Payment of Sinking of Well

The depth of sinking shall be measured from the natural bed level to the bottom of the well curb.

End of Chapter-9

PART 11

PARTICULAR TECHNICAL SPECIFICATIONS FOR CIVIL, STRUCTURAL AND PUMPING MAIN/SEWER NETWORK

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PART-11

PARTICULAR TECHNICAL SPECIFICATIONS FOR CIVIL, STRUCTURAL AND SEWER NETWORK

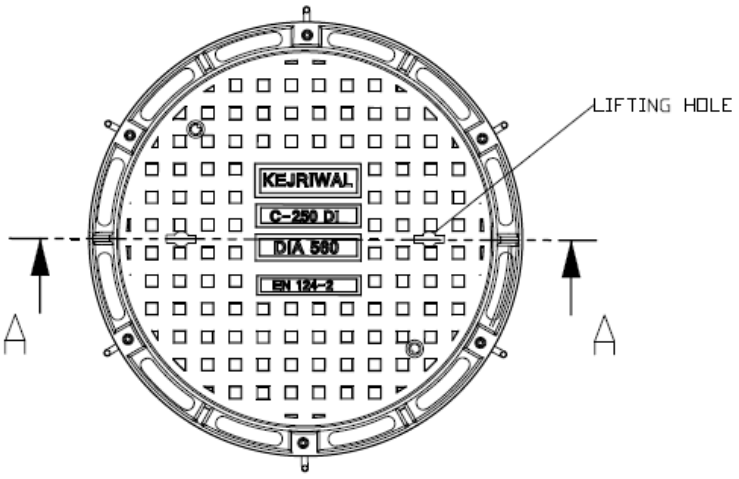
A. Standard Basic Specifications

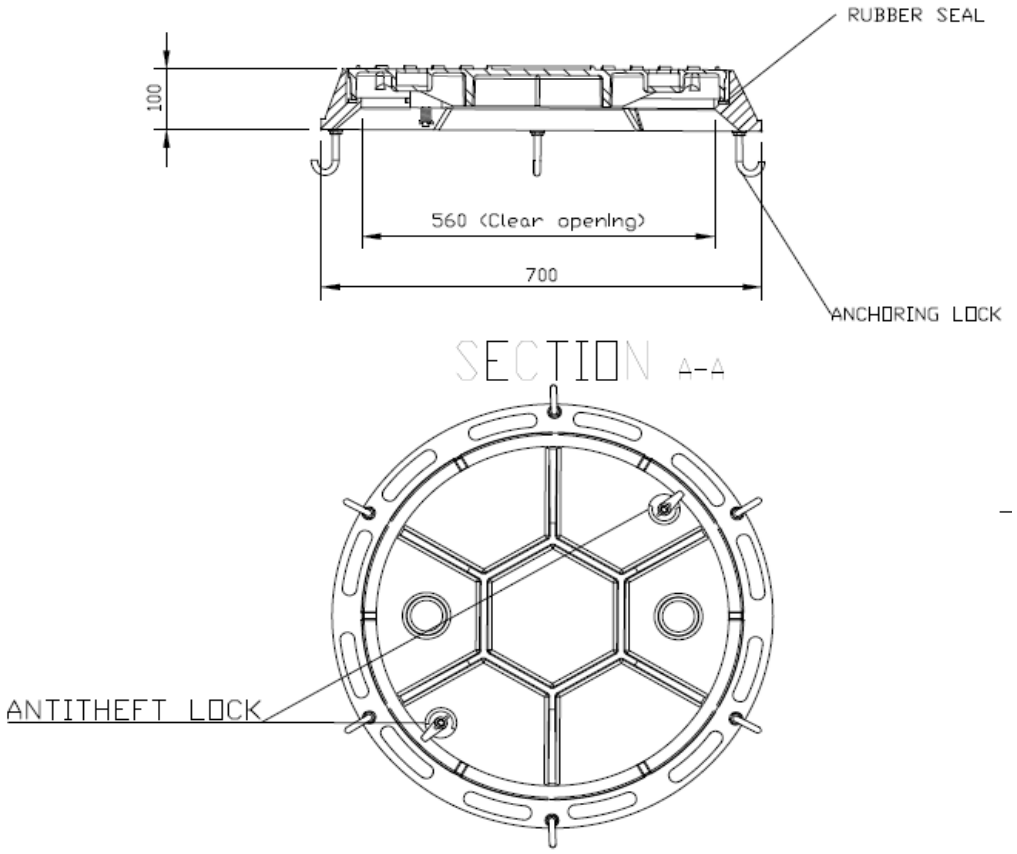
The "Standard Basic Specifications" Part-10 shall be followed for construction of General Works under this contract of BWSSB. Specifications for additional specialized items of civil works are as set out in Part 11, Particular Technical Specifications, of this Section.

In the event of any discrepancy between the provisions of the Standard Basic Specifications and the Particular Technical Specifications, the provisions of the Particular Technical Specifications shall prevail.

1.1 **DI Pressure Machinehole cover**

Pressure machinehole cover and frame DI with SS304 nut bolt arrangement with steel inserts shall be provided in lined and unlined storm water drains. The DI frame and cover of nominal size opening of 560mm internal diameter is proposed to be installed in the storm water drains and it is intended to make the machinehole frame and cover tight. Machinehole cover frame shall be manufactured according to BS EN 124_2 without hinge, with rubber ring gasket for sealing with round shape, including painting with black bitumen coating. The cover and frame shall be provided with threaded arrangement for fixing or arrangement for fixing frame and cover in with SS Bolts. Cover shall be coated with Zinc and black bitumen. The rubber ring gasket shall be as per IS5382 and shall be provided for making the frame and cover watertight. MOC of Anti-theft lock shall conform to IS 304, and anchoring lock MOC shall be MS. Weight of cover shall be in the range of 52-60 Kgs. Refer Sketch-1 for typical details of DI pressure machinehole details.





SKETCH-1 Typical details of DI Pressure Machinehole details

B. Particular Technical Specifications for Pumping main/Sewer Network and Allied Works

SECTION – 1

EARTHWORK EXCAVATION

1.1 Clearing site of large trees, structures etc.

This shall include the removal of large trees, stumps, structures, services such as cables, water supply, sewerage, storm water drains etc. or parts thereof lying along the alignment of sewer. The contractor should inform the Engineer before removing trees, structures, other services and structures etc. well in advance. Large trees and other valuables are the property of the Government, and they should be properly stacked along the side of the road and conveyed to the place as per the directions of the departmental Engineer. The cutting of trees or the demolition of structures is done in such a way that it should not disturb the traffic and pedestrians.

1.2 Removal of Top Soil, Shrubs and Other Vegetation

The work has to be tackled in between two adjacent Machineholes only. All shrubs, vegetation and other plants shall be removed and cleared from the selected stretch of the site. All debris and unsuitable material up to a depth of 30 cm between ground level and road level shall be removed. All debris and unsuitable material shall be carted away from the site as per the direction of the departmental engineer. The clearing and grubbing for trees upto 300 mm girth shall be removed. No separate payment shall be paid towards the above works and work includes loading, unloading, carting the material to a site selected by the contractor, disposal of unserviceable materials at his own cost.

1.3 General

Excavation shall be required to be done for the following works:

a) Excavations for underground sewer lines & pumping mains and other works as directed
b) Excavations for sewer lines below stormwater drains
c) Excavations for Machineholes, footings, pedestals and other works as required etc.
d) No separate payment shall be made for removal of shrubs, grass, large and small bushes, trees, stumps and stems of trees cut up to 300 mm girth, fencing including posts and gates and rate for the same shall be deemed to be included in the other pay items of BOQ

1.4 Preparatory Work, Sight-rails and Boning Staves

The centre line of the trench is first marked out on the ground duly driving pegs at convenient intervals. Before commencement of earth work excavation, levels shall be taken along the centre line of the proposed sewer at intervals of say 10 m and at the Machinehole locations. A longitudinal section (LS) of the profile of the ground surface showing the proposed sewer, indicating the gradients and giving the invert levels of the sewer as well as the Machineholes available at the tender stage, shall be updated based on the contractor's re-confirmatory survey and approved by the Engineer before taking up the work.

The width of the trench to be excavated is marked on both sides of the centre line and excavation lines cut out.

Two wooden posts 100 mm x 100 mm x 1800 mm high shall be firmly, erected/fixed across the centre line i.e on either side at nearly equal distance, from the centre line and sufficiently clear of all intended excavation such that the poles/posts are not disturbed during the course of execution of the work. These posts are so arranged and fixed that a sight-rail when fixed at a level against these posts shall cross the centre line of sewer or centre of the Machine hole , as the case may be.

The sight-rail made from 250 mm wide x 40 mm thick wooden planks shall be screwed to the poles. The sight-rails shall be truly horizontal. The centre line of the sewer shall be marked on the sight-rail by fixing a nail or otherwise as determined by the Engineer. The sight-rails may be fixed about 1.25 m above the ground, which is convenient distance for sighting by a levelling instrument. The sight-rails have to be so fixed that when a line sighted along the top edge of the sight-rails shall represent the true fall or gradient of the proposed sewer. This gradient is transferred below the ground level by means of boning-rod. Boning is carried out between the sight-rails with the help of a cord or a rope extended from nail to nail fixed on the sight-rails.

Boning rods with cross section 75 x 50 mm of various lengths shall be prepared with wood. Each length shall be a certain number of meters and shall have fixed tee-head. (A cross piece of 450x 100 mm is to be fixed with nails at the top of the boning rod so as to form shape like a Tee-square) and a cross piece about 300 mm long fixed at the bottom of the boning staff. The distance between the top of Tee head and the cross piece shall depend upon the site requirements viz, dia of pipe, depth of cutting, level of sight-rail, designed level of sewer, etc. The boning rod must be marked on two sides to indicate its full length. According to the circumstances of each case, a suitable length of boning rod, duly fixing the cross piece, will be determined upon the reduced level of the invert of pipe at each sight-rail.

The sight-rail and vertical posts shall be perfectly square and planed smooth on all sides and edges. This arrangement of erecting poles with sight-rail shall be done at suitable intervals depending on the site requirements, as directed by the Engineer. The posts and rails must in no case be removed until the trench is excavated, the pipes are laid and permission given to proceed with the filling in.

1.5 Probing Pits

Before starting the excavation of trenches, the contractor shall dig probing pits of size 1 m x 1 m and 1.5 m deep including road cutting at every 100 m interval along the alignment to accurately locate and determine the position of existing utilities and obstructions. The contractor shall refill the probing pits in layers of 15 cm with excavated earth up to the original ground level. In all cases the probing pits are to be excavated in accordance with the specification for excavation, refilling etc. No separate payment will be made for these probing pits and shall be deemed to be included in other pay items of the BOQ.

1.6 Utilities Protection

All utilities within the site, such as water, storm and sewage mains, shall be ascertained by probing pit results at various intervals or as required.
All utility lines and structures, whether indicated on the drawings or not, which are to remain in service shall be protected by the contractor from any damage likely to result from his operations. Any damage to any utility resulting from the contractor's operations shall be repaired at the contractor's expense.

1.7 Pavement Removal

The contractor must inform the Engineer before the starting of work well in advance so that it can be communicated to other concerned departments. The contractor must provide and maintain proper and efficient traffic control system such as safety lamps, sign boards etc. operating day and night for the full

duration of work. The BWSSB shall not be responsible under any circumstances for any mis happenings. For the purpose of payment for removal of pavement, steel tapes are to be used and the measurement shall be taken jointly by the Engineer's representative and contractor or his representative. The maximum width of trench excavation shall as per relevant Indian standards or outer dia of the pipe + 0.3 m whichever is lower and only such widths shall be taken into account for computing quantities for payment. For other elements of work such as Machineholes, making cross connections, fixing other appurtenances etc. the engineer shall prescribe the dimensions for removal of pavement from time to time.

1.8 Maintenance of Traffic and Closing of Streets

The work shall be carried out in such a manner which will cause the least interruption to traffic, and the road/street may be closed in such a manner that it causes the least interruption to traffic, Where it is necessary for traffic to cross open trenches, suitable bridges shall be provided. Suitable signs indicating that a street is closed shall be placed and necessary detour signs for the proper maintenance of traffic shall be provided.

1.9 Soil Investigations

Soil analysis reports of proposed sewer alignment are available with BWSSB office. Additional soil tests, if necessary, shall be carried out along the alignment, and the soil boring logs shall be prepared by the contractor at his own cost. Where off-site materials have to be used, the contractor shall, if the Engineer desires, make available certified soil test reports including information regarding sieve analysis, plastic limit, liquid limit, maximum density, optimum moisture content, etc., from an approved testing laboratory.

1.10 Classification

The excavation work shall be classified into the following categories:

Sewer lines, Machineholes, pedestals and other works.

i) All soils: Loamy, clayey soils like BC soils, red earth, ordinary gravels, hard gravel, a mixture of gravel and soft disintegrated rock, ordinary gravel, stony earth, and earth mixed with boulders of 30 cm size, excluding disintegrated rock.

ii) Disintegrated rock, soft rock, soft shale, and medium hard rock comprising of lime stone, sand stone, hard shale schist, fissured rock or soft rock or conglomerate rock, to be removed by pick axes and crow bars, wedges and hammers with some difficulty including all types of laterite excluding hard rock

iii) Hard rock to be removed only by chiselling and benching/breaker, diamond rope cutting or as directed by the engineer.

1.11 Trench Excavation

General

Trench excavation means excavation of trenches into which the pipe is to be laid. The line and levels of trenches shall be as shown on the drawings or as may be directed by the Engineer. Before commencing trench excavation, the route of the trenches shall be pegged out accurately and the natural ground levels shall be agreed with the Engineer.

1.12 Width of Trench

The width of trenches measured at the crown of the pipe shall permit adequate working space. The trenches shall be widened at sockets and other structures as may be found necessary. The widths to be adopted are shown in respective drawings. If the widths of actual excavation are more than the specified, it has to be made by the contractor with no separate payment. Care should be taken to avoid excessive trench widths and thereby increasing the load on the pipes. The maximum width of trench excavation shall be as per relevant Indian standards for pipe laying or outer dia of the pipe + 0.3 m whichever is lower and only such widths shall be taken into account for computing quantities for payment. However, the minimum width of the trench shall be 600 mm.

1.13 Depth of Excavation of Trench

The depths for the trenches will be calculated from the surface to the bed of the pipes and in case when a layer of bedding is to be placed below the pipe line, the depth to the bottom of the bedding will be paid. The depth of excavation for Machineholes shall be measured from the surface of the existing ground level to the bottom of foundation. No payment will be given beyond this depth.

1.14 Maximum Length of Open Trench

The stretch of work to be tackled shall be limited to two adjacent Machineholes. However, the Engineer may permit only reasonable trench excavation in advance of the lengths between two adjacent Machineholes to ensure that laying and jointing of pipes can reasonably be expected to be completed and the trench refilled, and not attended to later than 3 days after excavation of the trench. The Contractor will not be permitted to keep trenches open for unduly long periods, creating public hazards. The Engineer's decision in this respect shall be final.

1.15 Trench Sides

Loose boulders shall be removed from the sides of the trenches before allowing workmen into the excavation, and the trench sides shall be stabilized with screening or other methods approved by the Engineer. Trench slopes shall be kept moist where necessary to prevent local sliding as ordered by the Engineer.

1.16 Widening Trench at Joints, etc.

Any widening or deepening of the trench, whether in ordinary soil or rock, necessary to accommodate curves, joints or bends as shown on the drawings or ordered by the Engineer shall be carried out by the contractor.

1.17 Over-excavation of trench bottoms

All excavation carried below the grades shown on drawings, shall be refilled with compacted bedding material at the Contractor's expense.

1.18 Excavated material

The material from the excavation shall be deposited on either side of the trench leaving clear berm on one side at least 40 cm wide or at such further distance from the edges of the trench as may be necessary to prevent the weight of materials from causing the side of the trench to slip or fall, or at such a distance and such a manner as to avoid covering fire-hydrants, sluice valves, Machinehole covers and the like and so as to avoid any wall or structure or causing inconvenience to the public or other persons or otherwise as the engineer may direct, till it is carted away.

The excavated soil should be so placed and handled as not to inconvenience the usual traffic, till it is carted away. The contractor should also provide necessary bridging over the excavated trenches for the house-holders and pedestrians to cross over and vehicular crossings if and where required at no extra cost, if the Engineer decides that there is no hindrance to traffic due to not carting away the excavated earth, he will give instructions to that effect.

The Machinehole frames and covers from the existing Machineholes shall be carefully removed and stored in a suitable place away from the trenches. The contractor should not break the Machinehole frames and covers while removing. The contractor is responsible for the safety of Machinehole frames and covers.

1.19 Pipe Bedding

i) Granular Bedding

The bed of trenches shall be prepared as per drawing. Sand used for back fill shall be natural sand (free from cinders, ashes, slag, refuse, organic materials, boulders, rocks or stones) graded from fine to coarse or manufactured sand as per BOQ & contract specifications. The total weight of clay in it shall not exceed 10%. All materials shall pass through a sieve of aperture size 6.30 mm.

ii) Gravel/Murram Bedding

The bed of the trenches shall be prepared as per drawings. The approved granular material shall be of size less than 25mm (murrum) and work shall include watering and consolidation by punners etc., complete with all lead and lifts, as per specification and as directed by the Engineer complete

iii) Stone dust or quarry dust Bedding

The bed of the trenches shall be prepared as per drawings**.** Bedding or Back filling shall be using approved stone dust/quarry dust of size not exceeding 5.6mm for the pipe line trenches and work shall include watering and consolidation to 95% proctor density etc., complete with all lead and lifts as per specification and as directed by the Engineer complete

iv) Concrete Bedding

This type of bedding is as per the drawing appended with the tender document, and is to be provided at locations shown in drawings or as specified by the Engineer. A concrete bedding as per BOQ provisions shall be provided mostly in weak strata and in storm water drains. The concrete work related to this specification is detailed in the specifications of concrete and allied works.

In case of sewers laying in storm water channels, the pipe shall be encased with cement concrete/reinforced cement concrete of grade as per BOQ provision with a minimum thickness of 150 mm all around or as per bedding drawing. If the clear distance between drain bed and pipe top is more than one meter then concrete bedding as directed by the Engineer shall be done.

1.20 Trench excavation in hard rock

If any material which in the opinion of the Contractor can be classified as hard rock is encountered, he shall immediately inform the Engineer and the level, extent and description of the material encountered shall be measured jointly and recorded before excavation.

Only such proportion of material notified and measured which is certified by the Engineer as "rock", shall be paid for as rock excavation.

Excavation for trenches in rock shall be so carried out such that the clearance between the pipe, when laid in position and the sides and trench bottom shall be kept to the minimum limits necessary to provide for specified thickness of bedding, and surround to the pipe as specified. Excavation outside the specified limits shall not be paid for and any additional expenses incurred in providing additional strength to the pipe to overcome the increased trench loads on account of increased width shall be at the Contractor's expenses. The rock thus excavated shall be auctioned as directed by Employer/Engineer as per GOK procedures and the auctioned amount shall be remitted to the Employer/Engineer.

1.21 Excavation for appurtenances

Excavation in trenches for foundation anchor blocks, pedestals etc. shall be as per the plan or as directed by the Engineer. The dimensions of the excavation shall be measured as the projection in plan of the outermost edges of the structure.

1.22 Pumping sewage or diversion by gravity and dewatering

General
The works included in this Section are as follows:

1) Provision of all labour, equipment, materials etc. to ensure a safe and dewatered condition in all areas in which the work in this contract are to be executed.
2) Continuous operation of the dewatering systems is required to complete all portions of the works where dewatering and pumping of sewage is necessary to prevent inflow, collection of surface water or ground water, or sewage or to protect adjacent properties or constructions from damage resulting from a rise or fall of ground water levels or sewage.
3) Removal of the equipment when no longer required.

1.23 Pumping out water and dewatering

The Contractor shall provide and work at his own cost, all pumps, engines and machinery requisite to keep the trenches for the sewers or foundations and all other excavations clear of water, whether sub-soil water, storm water, sewage, leakage from tanks, wells, drains, sewers, water mains or pipes etc., so that there may be no accumulations of such water and that no setting out may be done, no masonry may be laid, no concrete deposited, no joints made and no measurements taken in water.

The pumping shall be continued so long after execution of any portion of the work and repeated as often as the Engineer may consider necessary. The pumps and power applied must be such as the Engineer may determine to be sufficient to any particular time so that he may stop the work altogether until he is satisfied and also impose a fine upon the contractor.

The Contractor shall be responsible for the adequate pumping, drainage and bailing out of water from the excavation with all rates of recuperations. Dewatering shall be either continuous or intermittent using method approved by the Engineer. The method of dewatering shall depend on site condition should be furnished by the Contractor and approved by the Engineer. The method of dewatering shall be either sump pumping or well point dewatering. The effectiveness of each method will depend upon the nature of the soil, the proportions of the trench and degree of lowering required. Pumping test may be necessary to determine which method is suitable. If sump pumping is not practicable other control methods shall be considered and should be approved by the Engineer. The trenches should be kept dry till the completion of work, which includes excavation, pipeline laying, jointing, testing and

commissioning and backfilling. Precaution should be taken against the flotation of the pipes. The Contractor shall conduct ground studies if necessary and the cost for such studies have to borne by the Contractor himself.

The Contractor shall be responsible for the adequate pumping, drainage and bailing out of water due to the excavation for laying sewer pipe lines and all types of constructions. In case of failure to make such provisions or any other provisions, which may result in unsuitable sub-grade conditions, the Contractor shall replace and repair the sub-grade as directed to the satisfaction of the Engineer, at his own cost and responsibility.

Should the Contractor select to use a gravel sub-grade with or without unjointed pipes with the gravel layers to facilitate flow of water to pumps or other points of disposal, such gravel sub grade with or without conveying pipes shall not be measured or paid as an extra item and rate for the same shall be deemed to be included in the other pay items of BOQ.

1.23.1 Sump pumping

This method may be used in highly and moderately permeable soils such as gravels, sand and gravel mixtures. This method is simple and cheap to install and used with watertight trench sheeting to limit the volume of flow. To prevent the boiling in the bottom of the trench the following precaution should be taken.
Drive sheeting deeper to lengthen drainage path;
Use open pipe surrounded in gravel as a sump;
Move the sump to one side of the trench;
To prevent removal of fines from soil causing loss of strength in the soil and undermining of the trench bottom and side support, surround suction inlet with protected graded filter;
Increase flow rate through the soil by using open pipe surrounded with gravel.

The delivery side of the pump should be monitored by taking samples of water and checking the proportion of fines being removed. If fines are being continuously withdrawn or there are signs of trench instability, sump pumping should be stopped and alternative methods considered.

1.23.2 Well pointing

In this method well points are installed at regular intervals on one or both sides of the trench and linked parallel to a header main connected to a pump. Well points are usually installed at 0.6 to 2.0 m centre to centre by jetting them in. In ground with dense layers or cobbles & boulders, it may be necessary to pre-bore the layers. The efficiency of the well points is increased by sanding in the well point and riser using a column of sharp sand. This method has an advantage of drawing water away from the trench and in suitable conditions is effective in lowering the water by 4 to 6m below excavation level. It will also reduce the hydrostatic heads on the trench support system. Its greatest use in sand, the heavy flows impermeable ground, such as gravels, means that the well points have to be so close together that the method becomes impractical. In clays the rate of seepage is too small for the system to be properly effective. Silts can be stabilized in certain conditions by using special procedures.

The well pointing shall be either single sided well point or double sided well point. For higher depths double sided well point with multi stage shall be considered. Should the Contractor select to use a gravel sub-grade to facilitate flow of water to pumps or other points of disposal, such gravel sub-grade shall not be measured or paid for as an extra item. Contractor should assess the availability of extra earth required for refilling in case of shortage in any particular reach well before quoting rates.

Even in case the Contractor resorts to mechanical excavation, the Contractor should take care of proper refilling, consolidation and disposal of surplus earth.

Disposal of ground water is to be away from the area of influence of the pipe laying area Suitable temporary pipelines are to be laid to existing watercourses. For lowering the sub soil water level for the construction of wet wells the bores have to be installed/jetted at distance between two bores varying from 0.6 to 1.0m depending upon sub strata and the incoming flow of water. The bore should be installed at least 1.0m away from the periphery of the excavated earth. The dewatering includes removal of ground water, springs, seepage water, sullage, sewage, running water, rain water etc., in order to make the trench for pipe line works etc. It is to be noted that contractor can adopt the suitable type of dewatering to keep the trench dry until completion of all sewer laying and testing works.

1.24 Keep excavation clear of water

Where ground water/Nallah surface flow is encountered or anticipated the contractor shall provide sufficient pumps to handle the ingress of water and must provide and maintain in working order. Standby pumping units are to be made available and employed in the event of mechanical failure. The contractor must also arrange for night and day operation of the pumps wherever necessary to ensure that the work proceeds at all times.

1.25 Barricading, watching, lighting

The parts of the barricading shall be of timber, securely fixed in the ground not more than 2.50 m apart. They shall not be less than 10 cm in diameter and not less than 1.5 m above the surface of the ground. There shall be two rails, one near the top of the posts and the other about 0.50 m above the ground and each shall be of 5 cm to 10 cm in diameter and sufficiently long to run from post to post to which they shall be tied with strong ropes or the work shall be carried out as per BOQ provisions.

The method of projecting rails beyond the posts and tying together where they meet will not be allowed on any account. All along the edges of the excavated trenches, a bund of earth about 1 m high shall be formed when so directed by the Engineer for further protection. Proper provision shall be made for lighting at night and watchmen shall be kept to see that this is properly done and maintained. In addition to the normal lighting arrangements the contractor shall provide, whenever such work is in progress, battery operated blinking lights (6 volts) in the beginning and end of a trench with a view to provide suitable indication to the vehicular traffic. The contractor shall also provide and display special boards printed with fluorescent prints indicating the progress of work along-the road. Further, in all such cases the work may be carried out departmentally at the risk and cost of the contractor. The contractor shall be held responsible for all claims for compensation as a result of accident or injury to person and non-provision of red flags.

The Contractor shall at his own cost provide all notice boards before opening of roads as directed by the Engineer.

Arrangements shall be made by the contractors to direct traffic when work is in progress. No separate payment shall be paid for this item of work.

1.26 Refilling trenches

1) With a view to restrict the length of open trenches, on completion of the pipe, laying operations, refilling of trenches shall be started immediately by the contractor. Pipe laying and testing shall follow closely upon the progress of trench excavation and the contractor shall not be permitted unreasonable excessive lengths of trench excavation to remain open while awaiting testing of the pipe line.

2) The trench shall be filled by borrowed gravel or approved material up to at least 30 cm. above the top of pipe, back filling is to be done keeping at least 90 cm. length of pipe open at the joints, for verification of joints for water tightness during testing.

3) Care shall be taken while back filling, not to injure or disturb the pipe. Filling shall be carried out simultaneously on both the sides of the pipes so that unequal pressure does not occur.

4) Walking or working on the completed pipeline shall not be permitted unless the trench has been filled to a height of at least 30 cm over the top of the pipe except as may be necessary for tamping, etc., during back filling work.

5) Filling-in shall be done in layers not exceeding 150 mm in thickness accompanied by adequate watering, ramming, etc., so as to get good compaction up to 300 mm above the top of the pipe. Above this level, useful excavated earth free from boulders shall be placed in layers of 150 mm, watered and compacted by tamping. Wherever pipe is laid in the storm water channel, total refilling shall be done with borrowed earth or as directed.

6) The trench shall be refilled so as to build up to the original ground level, keeping due allowance for subsequent settlement likely to take place.

7) Before and during the backfilling of the trench, precautions shall be taken against the floatation of the pipeline due to the entry of large quantities of water into the trench causing an uplift of the empty or the partly filled pipeline.

8) In case of sewers laid in storm water channels, after refilling is done, the bed of the channel to the extent trench width shall be made with cement concrete of grade M15 with a thickness of 150mm as per the site requirement and as directed.

9) Optimum Moisture Content (OMC) test to be carried at trench section and Maximum Dry Density (MDD) test for the refilled soil in trench to confirm the proper compaction up to 95% of maximum dry density.

1.27 Refilling the road surface

After the backfilling is completed, the contractor shall restore the surface of the trench over the pipe to that road surface existing prior to excavation, i.e., either bitumen or cement concrete as the case may be and verified from the adjacent surface. This will be paid as per the Bill of Quantities. The width for the payment of road cutting or restructuring will be only as per the direction of the Engineer. The work of restructuring of road surface either by bitumen or cement concrete shall be as described in chapter Road restoration.

1.28 Subsidence in filling

Should any subsidence take place in the filling at any place of work i.e. at Machineholes and over pipe trenches and road surface whatsoever during contract, the contractor shall make good the same at his own cost or the engineer may with or without notice to the contactor make good the same in any way and with any material that he may think proper, and at the expense of the contractor. The

engineer may also, if he anticipates the occurrence of any subsidence, take necessary action deemed fit in which case also the expenses therefore shall be charged to the contractor.

1.29 Disposal of excavated materials

Excavated materials shall be used for refilling etc. and surplus earth shall be disposed off to the outskirts of corporation safely with all leads and lift as directed by the engineer. In case of pipe laying work to be carried at the outer periphery of the lakes, the excess material shall be used for filling and embankment formation along the outer periphery of the lakes for laying of the sewer network

1.30 All works to be clear, clean and perfect

The Contractor, after completion of entire work and before seeking settlement of his final bill, shall prove at his expense that the entire line is clear, clean and perfect in the presence of the Engineer or his authorized subordinate. He should provide suitable instruments, appliances etc., and pass them through the pipes and shall show that water passes freely through the entire reach from higher end to lower end. Necessary precautions such as those indicated hereunder may be taken by the Contractor while checking the completed sewer line for its effective functioning, wherever required.

The Machineholes should be kept open, as required for one hour or as required, prior to the starting of checking operations and should be so kept open during the whole duration of checking operations. This is to be done for allowing the gases to escape, naturally. In order to prevent fire and explosions, endangering the life, properties, sewers and other utility services due to presence of combustible gases, no lighted match sticks or other similar material should be thrown in the Machinehole . All necessary safety equipment's, gadgets and sensors shall be used in the restricted working areas.

Meshes should be placed over the opened Machineholes to prevent pedestrians etc., from falling in. Likewise, caution boards printed in fluorescent letters such as "DANGER MACHINEHOLE IS KEPT OPEN" etc., shall be provided.

1.31 Laying of sewer pipes along the water body

It is to be noted that sub-mains/trunk lines need to be laid along the edge of tank/water bodies. If permitted, the edge of the tank shall be first filled with earth and later pipe laying work can be taken up and the excess soil shall be used for this purpose.

1.32 Measurement

The measurement of excavation shall be made on quantity basis as per the actual dimensions of the trench excavated limited to the width shown in the drawings or as directed.

a) Trench excavation

The length of the trench excavation shall be measured along the centre line of pipe at various depths stated in the Bill of Quantities, the total length being segregated into stretches according to the various depths of excavation contained in the Bill of Quantities to fall into the specified categories. Within each stretch the depth applicable shall be within the range specified in Bill of Quantities.

The depth of excavation shall be measured from the top of the trench at the centre before excavation upto the bottom of the bedding under the pipe. If no bedding is provided, the measurement shall be to the level of the bottom of the pipe line. The width of the trench shall

be measured on the basis of vertical side walls and the specified widths. No additional payment shall be made for the widening at sockets, specials, hunching or surrounds beyond the dimensions specified.

b) Structures

Measurement for structure excavation shall be made as per the projection in plan of the outermost edges of the, structure as per the plan at the bottom.

c) Rock excavation

The depth of rock excavation measured for payment shall not exceed the corresponding depth in ordinary excavation or as directed by the Engineer.

In all above cases, no payment will be made for additional selected fill, lean concrete, bedding cradling or hunching concrete that may be specified or ordered by the Engineer as a consequence of excavating beyond the limits specified in the contract documents or ordered by the Engineer.

The contractor has to auction/dispose/use himself the excavated hard rock as per GOK guidelines and the revenue generated in this manner will be recovered in his payment at the prevailing rate of Royalty with applicable GST.

d) Disposal of excavated material

All the excavated material shall be carted away with all lead and lift and it includes loading, unloading, transporting with all lead and lift and as per Engineers directions.

SECTION 2

CONCRETE AND ALLIED WORKS

2.0 General

The quality of materials and method and control of manufacture and transportation of all concrete work irrespective of mix, whether reinforced or otherwise shall conform to the applicable portions of this specification.

The Engineer shall have the right to inspect the source/s of material/s, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and Engineer's approval obtained, prior to starting of concrete work. However, this shall not relieve the contractor with any of his responsibilities and all the materials, which do not conform to the specifications, will be rejected. The detailed specifications are provided in Part 10-A, Standard Technical Specifications

SECTION- 3

SEWER APPURTENANCES

3.1 Machineholes

The Machinehole shall be provided with RCC Machinehole depending upon diameter of sewers and depending upon the alignment of proposed sewer whether it is on road or in Storm Water Drain (SWD)/in WwTP/ISPS premises.

The Precast/Cast In-situ RCC are defined with the following conditions.

- RCC Precast Machineholes –for all depths
- RCC Cast in situ Machineholes – In storm water drains, for all dia. of pipe and for all depths.

It is intended to Construct RCC precast/Cast in situ Machineholes for the proposed sewerage system

(i) Location

Machineholes shall be constructed at places as shown on relevant drawings and as directed by the Engineer.

(ii) Excavation

Excavation, shoring, dewatering etc. for the pits of Machineholes shall be done in accordance with specification.

(iii) General

In general, plain and reinforced concrete work for Machineholes shall be carried out in accordance with the specification and drawing. The RCC Precast/Cast in Situ Machineholes shall be of minimum RCC M30 grade concrete using sulphate resistant cement.

Construction of RCC Machinehole chambers of in M30 grade proportion or approved type pre-cast RCC Machinehole chambers, constructed using form vibrators of standard type, with barricading, danger lighting and using of sight rails and boning rods whenever necessary, shoring and strutting wherever required using sulphate resistant cement, with minimum M30 grade RCC with 20 mm and downgraded jelly, well graded sand and steel of approved quality, minimum 200 mm thick top concrete slab or as per approved drawings, having wall thickness and raft thickness as in approved drawings and with an offset in raft all-round the chamber as in approved drawings.

Benching concrete with 1:6 slope towards the central drain finished smooth, including fixing and grouting of pipes, including conveying to work spot supply and fixing of SFRC Machinehole cover and frame (Heavy duty) confirming to IS 12592 with latest amendments, on a bed of CC 1:2:4 supplying and fixing of minimum 3 mm thick encapsulated plastic footsteps (as per IS 10910) on 12 mm dia Grade FE-500 steel bar (as per IS 1786) staggered at 300 mm apart as detailed in technical specifications, including sand & boulder bedding wherever required, disposal of surplus earth, dewatering until completion of works, curing, engraving Machinehole number with flow direction on the inner cylindrical surface etc complete including cost of reinforcement steel and fabrication charges, shuttering, shoring, keeping the trench dry until completion of works, including cost of transportation and erection of pre cast members from yard to site and also cost and conveyance of all materials, labour complete with all lead and lift. The precast RCC Machinehole/Cast in situ

chambers are for various diameters and depths as per detailed drawings, specifications and direction of the Engineer

The RCC Precast Machineholes shall be of minimum RCC M30 grade concrete. The Machinehole shall be constructed using sulphate resistant cement. The rubber seal joints shall be provided in between precast units, rubber gaskets shall be as per IS 5382. The joints shall be sealed with non-shrink grout. Single rubber seal shall be provided in between precast units. All reinforcement bars shall be HYSD CRS bars of grade FE 500 confirming to IS 1786. The non-core opening shall be 100 mm greater than the outer diameter of the pipe. The lifting holes shall be filled with Concrete. It may be noted that single offset joint configuration shall be adopted at the joint. Based on the site requirement, direction of the Engineer, or at the request of the contractor, contractor can construct cast in-situ Machineholes in place of precast Machineholes with contractors approved design and drawings in restricted areas. Provision for house service connection pipes if required shall be provided as per the direction of the Engineer.

The Machineholes shall be constructed at places as shown on the Sewer network drawings, issued during execution or wherever directed by the Engineer.

(iv) Cement concrete channel

The channel for the Machinehole shall be constructed in cement concrete of M15 grade. Both sides of the channel shall be taken up to the level of the crown of the outgoing sewer. They shall be benched up in concrete extended vertically 50mm above and rendered in cement mortar (1:2) of 20 mm thickness and formed to a slope of 1 in 6 towards the channel.
The branch channels also be similarly constructed with respect to the benching but at their junctions with main channel, an appropriate fall, if required suitably rounded off, in the direction of flow in main channel shall be given.

(v) Pipe entering or leaving Machinehole

Whenever a pipe enters or leaves a Machinehole, the pipe shall be encased with the concrete all around the pipes covering the joints.

(vii) Rungs / foot steps

Rungs / footsteps shall be provided in all Machineholes and shall be Manufacture and conforms to the dimensions of IS 5455:1969 are reinforcement encapsulated with PVC. The surface finish shall have 2mm tread on top by ribbing or chequering. These rungs may be 300 mm apart vertically and shall project a minimum of 100 mm beyond the finished surface of the machinehole wall. The top rung shall be 450 mm below the machinehole cover and the lowest not more than 300 mm above the benching. Rungs shall be tested as per IS and approved before usage.

(viii) Frame and covers

Frame and covers for Machineholes shall be of required type and dimensions as per the relevant drawings.

Following information shall be clearly marked on each cover.

a. Year of manufacture
b. Identification mark of the purchaser
c. SEWER / SWD

d. Arrow showing direction of flow
e. Name of manufacturer / Trade mark

(xi) Steel Fibre Reinforced Concrete (SFRC) Frame and Cover

Steel Fibre Reinforced Concrete (SFRC) frame and cover shall be as manufactured as per IS 12592. (Latest edition). The contractor to submit the structural design and drawing of frame and cover and get it approved before manufacturing the same.

(xii) Drop Machinehole

When a sewer connects a main sewer, and where the difference in level between water line (peak flow levels) of main line and the invert level of branch line is more than 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or impractical to arrange the connection within 600 mm, a drop connection shall be provided for which a machinehole shall be constructed as per relevant drawing, incorporating a vertical drop pipe from the higher sewer to the lower one. A continuation of the branch sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with a half blank flange. The diameter of the back drop should be at least as large as that of the incoming pipe. The drop pipe should terminate at its lower end with a plain or duck-foot bend turned so as to discharge its flow at 45 degrees or less to the direction of the flow in the main sewer.

(xiii) Measurement - Machineholes

The depth of machinehole shall be measure from the top of cover to the invert level of the deepest outgoing sewer from the machinehole. The measurement shall be per number basis and as per the actual depth of machinehole constructed.

Notes:

If any damage is caused to the other services such as water supply pipeline, sewer, cable/ other utilities etc. during the construction of Machineholes Contractor shall be held responsible for the same and shall replace the damaged services at his own cost to the full satisfaction of the Engineer.

The interior of Machineholes shall be cleared of all debris after construction and before testing the same for water tightness by Contractor at his own cost.

Water for testing of Machineholes along with pipeline shall be arranged by Contractor at his own cost.

3.2 Existing connections

All existing connections which are removed during the uprooting of the existing sewer if any shall be replaced and reconnected with new sewer as per the directions of the Engineer. The replaced new sewer connections shall be properly laid, jointed and connected as per the directions of the Engineer. During the execution work of replacing sewer if the bedding of the connection has been disturbed it shall be replaced with new bedding as per specification contained in the tender document. After making the connection to the sewer, back filling shall be done in layers as directed by the Engineer.

3.3 Ventilation shafts

Ventilation shafts are to be provided for the Machineholes in SWD or at places as directed by the Engineer. The connecting pipe from machinehole to ventilating shaft shall be DI K-9 150 mm diameter. A foundation block of 150mm thick PCC in M15 is provided surrounding the pipe. The vertical shaft should be made of ductile iron and it should be around 6 m high above the ground level and the internal diameter of the shaft should be 150 mm. All the dimensions are to be taken as per tender drawing. The joint of pipes forming the ventilating shaft should be made air tight. The location of the ventilating shaft should be such that it should not cause any nuisance to the vehicular traffic and the movement of pedestrians. The placing of ventilating shaft should be as per the directions of Engineer in charge. The details of fixing the ventilating shafts are provided in the drawing under volume 4 of the tender document.

3.4 Concrete cradles, haunching, etc.

The concrete cradles shall be constructed in situ by the contractor, indicated in the drawings, in places wherever required as decided by the Engineer.

Precast Concrete Blocks (Anchor blocks)

It is proposed to lay part of the DWC pipes besides/inside storm water drains or in water logged areas. It is intended that the contractor shall dewater/divert and keep the trench dry before laying of the pipes. The contractor shall provide the anchor blocks or uplift arrangements as per the Good for construction drawings, issued during execution and as directed. The contractor shall provide precast anchor blocks or uplift arrangements as per the BOQ provisions and as per drawings.

SECTION -4

SPECIFICATION FOR SFRC MACHINEHOLE COVERS

4.1 Scope

Contractor's scope includes the design, manufacture, supplying and fixing the SFRC machinehole frame and covers. The wet concrete mix is subjected to pressure applied through a hydraulic jack through a plunger kept at the top of the wet mix. The SFRC machinehole covers shall be able to resist 20 tonnes load bearing capacity. The dimensions shall be as per IS:12592. A 25x3 mm thick MS Flat all around the frame is welded to the main reinforcement of the frame so as to get a clear opening of 560 mm diameter. A 18 SWG MS strap all around the cover and lifting arrangement of 12 mm diameter MS bars welded to the main reinforcement are also to be provided for lifting the machinehole covers. A coat of epoxy paint shall be applied to the underside and sides of the frame and cover.

4.2 General

a) The quality of materials, method of testing shall be approved by the Engineer.

b) The Engineer shall have the right to inspect the source/s of material/s, the layout and procurement, the equipment, quality control system, testing of material etc. If the Engineer desires the sample of the SFRC cover or materials used for the manufacture of SFRC covers, test certificate from approved laboratory. Then the contractor shall arrange the same without any extra cost.

4.3 Material

a) Cement

Unless otherwise specified in the specification or called for the engineer, cement shall be ordinary Portland cement as per the relevant IS code. More details are mentioned on the section of concrete under this tender document.

b) Fine aggregates

The details of this have been mentioned in the section concrete and allied works of this tender document.

c) Coarse aggregate

Coarse aggregate for concrete, shall conform to IS:383. This shall consist of crushed stone and shall be clean and free from elongated flaky or laminated pieces, adhering coating, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or other deleterious matter, the maximum size of the aggregate shall be 12 mm.

d) Water

Water for use in concrete and curing shall conform to IS:456/1964 and its subsequent amendments.

4.4 Water/Cement ratio

The water-cement ratio shall *be 0.40 to 0.45 to* yield a good workability. The workability can be increased by using appropriate admixtures.

4.5 Fiber Reinforcement

The fibers are cut from 0.40 mm dia high tensile steel wires of about 12000 kg/cm2 ultimate stress. The fiber content for the manufacture of FRC covers is of the order 1 to 1.25% by volume of the concrete.

4.6 Design Mix

The vendor shall design the mix design of the concrete which is expected to give a concrete compressive strength as per IS:12592

4.7 Mixing

Concrete shall be mixed in a mechanical mixer. Mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency.

4.8 Placing and compaction

The reinforcement shall be placed in proper position in steel moulds coated with a thin layer of mould oil. Concrete shall be filled to slightly overfill the moulds and compacted by vibration and struck off level with a trowel.

Use of needle vibrators for compacting the wet concrete mix containing fibres is not recommended since the holes left by the vibrator in the wet mix may not close after its removal owing to interlocking of the fibres with the mix. Compaction by means of shutter or form or table vibrators is recommended. In case of extra heavy duty and heavy duty cover frames, compaction by means of pressure cum-vibration technique may also be employed so as to achieve dense and strong concrete. Clear cover to reinforcement shall be not less than 15 mm. After de-moulding, cover frames shall be protected until they are sufficiently hardened to permit handling without damage.

4.9 curing

The hardened concrete machinehole cover frame shall be placed in a curing water tank or taken to the curing yard where they shall be kept continuously moist for at least 28 days. Frames may be water cured by immersion in water, covering with water saturated material or by a system of perforated pipes. Mechanical sprinklers or any other approved method that will keep covering frames moist during the specified curing period. Steam curing of machinehole cover frames may be adopted instead of method specified above provided the requirements of pressure or non pressure steam curing are fulfilled and the machinehole cover frames meet the requirements specified in this section.

4.10 Edge Protection and finishing

The top and inside surface of cover frames shall be smooth. To prevent the top outer edge from possible damages, it shall be protected by 25 mm x 3 mm mild steel flat as part of the frame. Sufficient number of steel connectors shall be welded to the inner surface of the mild steel flat so as to connect it with the frame reinforcement and these shall be embedded in the concrete during casting. Exposed surface of mild steel flat shall be given suitable treatment with anticorrosive paint or coating. Suitable arrangements may be made for fixing the machinehole cover frames in position on the Machineholes by mutual agreement between the manufacturer and the purchaser.

4.11 Physical requirements

4.11.1 General

All the frames shall be sound and free from cracks and other defects which interferes with the proper placing of the units or impair the strength or performance of the units. Minor chippings resulting from the customary methods of handling and transportation shall not be deemed ground for rejection.

1. Dimension

The inside dimensions at top shall match with the corresponding covers so that the maximum clearance at top between the frame and the cover is not more than 5 mm and the top surface of the frame and cover is in level within a tolerance of ± 5 mm.

2. Scale of Sampling - LOT

In a consignment of 500 precast concrete machinehole cover frames or a part thereof, of the same type and dimensions and belonging to the same batch of manufacturer, shall be grouped together to constitute a lot. For ascertaining conformity to the materials in the lot to requirements of this specification, samples shall be tested from each lot separately. The number of cover frames to be selected from the lot shall depend on the size of lot and shall be according to the following table:

Scale of sampling and permissible number of defectives

No. of cover Frames in the Lot Dimensional Requirement

	Sample Size	**Acceptance Number**
Up to 100	10	1
101 to 200	15	1
201 to 300	20	2
301 to 500	30	3

SECTION – 5

RCC SOCKET SPIGOT NON-PRESSURE PIPES

5.1 General

RCC NP3 and RCC NP4 class pipes shall be used as per the requirement. These pipes shall be in accordance with the specifications mentioned in IS:458-2003 and its Amendments. These proposed pipes shall be in accordance with the specifications mentioned in relevant IS and for which no extra cost other than the one which is mentioned in BOQ will be paid.

5.2 Materials

For pre-cast reinforced concrete pipes, materials complying with the requirements given in (i) to (v) shall be used.

a) Cement

Cement used in RCC NP3 pipe should be with Sulphate resistant cement and conforms to IS: 12330-1988

b) Aggregates

Aggregates used for the manufacture of reinforced concrete pipes shall conform to IS:383-1970. The maximum size of aggregate should not exceed one third the thickness of the pipe or 20 mm, whichever is smaller.

c) Reinforcement

Reinforcement used for the manufacture of the reinforced concrete pipes shall be mild steel Grade I or medium tensile steel bars conforming to IS: 432 (Part1):1982 or hard drawn steel wire conforming to IS: 432 (Part 2) or structural steel (standard quality) bars conforming to IC: 2062.

d) Concrete or Mortar

The quality and design mix requirements of concrete (concrete mix, maximum water-cement ratio, minimum cement content, etc) used for the manufacture of reinforced cement concrete pipes and collars shall conform to IS:456-2000 for at least very severe environment exposure condition and shall also be in accordance with Concrete and Allied works Section of Technical Specifications. In case of pipes cast by spinning process, higher cement contents, more fines and higher water-cement ratio may be the need of the process.

The concrete for non-pressure pipes shall have a minimum compressive strength of 35 N/mm2 at 28 days. If mortar is used, it shall have a minimum cement content of 450kg/m^3 and a compressive strength not less than 35 N/mm2 at 28 days.

Compressive strength tests shall be conducted on 15 cm cubes in accordance with the relevant requirements of IS:456-2000 and IS:516-1959.

The manufacturer shall give a certificate indicating the quantity of cement in the concrete mix.

i) Rubber Ring

Rubber ring chords used in pipe Joints shall conform to Type 2 of IS:5382-1985.Rubbers rings shall be tested and approved before usage.

5.3 Design

i. General

Reinforced concrete pipes either spun or vibrated cast shall be designed such that the maximum tensile stress in the circumferential steel due to specified hydrostatic test pressure does not exceed the limit of 125 N/mm^2 in the case of mild steel rods, 140 N/mm^2 in the case of hard-drawn steel wires and high strength deformed steel bars and wires.

The barrel thickness shall be such that under the specified hydrostatic test pressure, the maximum tensile stress in concrete, when considered as effective to take stress along with the tensile reinforcement shall not exceed 1.5 N/mm^2 for non-pressure pipes. The barrel wall thickness shall be as per IS:458-2003.

Longitudinal reinforcement shall be provided to ensure rigidity and correct location of cages (grids) longitudinally and to limit the effects of transverse cracking. Minimum longitudinal reinforcement shall be as given in respective tables of IS:458.

ii. Reinforcement

The reinforcement in the reinforced concrete pipe shall extend throughout the length of the pipe and shall be so designed that it may be readily placed and maintained to designed shape and in the proper position within the pipe mould during the manufacturing process. The circumferential and longitudinal reinforcement shall be adequate to satisfy the requirements specified under (i).

The pitch of circumferential reinforcement shall be not more than the following:

a) 200 mm for pipes of nominal internal diameter 80 to 150 mm,
b) 150 mm for pipes of nominal internal diameter 200 to 350 mm, and
c) 100 mm for pipes of nominal internal diameter 400 mm and above.

The pitch shall also be not less than the maximum size of aggregate plus the diameter of the reinforcement bar used.

The quantity and disposition of steel in pipes may be decided by mutual agreement between the BWSSB and the supplier; however, it shall be proved by calculations and tests that the quality of the pipes conforms to all the requirements specified in the standard. In the absence of calculations and tests, the reinforcement given in the respective tables of IS:458 shall be used as minimum reinforcement.

If so required by the BWSSB, the manufacturer shall give a certificate indicating the details relating to quality, quantity and dispersion of steel in the pipes as well as the clear cover to the steel provided in the pipe.

iii. Ends of Pipes

Dimensions of spigot and socket for rubber ring roll on jointed pipes shall be as given in the respective tables of IS:458. Reinforcement in socket of rubber ring jointed pipes shall be as given in the respective tables of IS:458-2003.

5.4 Manufacture

5.4.1 General

The methods of manufacture shall be such that the form and dimensions of the finished pipe are accurate within the limits specified in this standard. The surfaces and edges of the pipes shall be well defined and true, and their ends shall be square with the longitudinal axis.

ii) Concrete mixing

Concrete shall be mixed in a mechanical mixer. Mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour ad consistency, but in no case shall the mixing be done for less than two minutes. Water-cement ratio shall be less than 0.5.

The concrete shall be placed before setting has commenced. It should be ensured that the concrete is not dropped freely so as to cause segregation. The concrete shall be consolidated by spinning. Vibrating, spinning combined with vibrations, or other appropriate mechanical means.

iii) Reinforcement Cages

Reinforcement cages for pipes shall extend throughout the length of pipe barrel. The cages shall consist of spirals or rings and straight of hard-drawn steel wire or mild steel rod and may be circular. Circular cages and longitudinal reinforcement shall be placed symmetrically with respect to the thickness of the pipe wall. The spirals shall end in a complete ring at both the ends of a pipe.

Pipes having barrel thickness **above 100 mm** shall have double reinforcement cage and the amount of steel in the outer cage shall be 75% of the mass of the inner cage whilst the total shall conform to the requirements specified in the relevant tables of IS 458 : 2003. The total longitudinal steel per pipe shall be given in the relevant tables of the standard but the distribution shall be such that the round shape of the cage is not disturbed.

Diagonal reinforcement may be provided in pipes for which the cages are not welded so as to help in binding the cage securely. It shall, however, be ensured that the clear cover for any reinforcement is not below the limits specified in **6.4 of IS 458.** If diagonal reinforcement is provided, it shall be considered as part of process requirement and shall not be counted against the longitudinal reinforcement and spiral reinforcement. Single reinforcement cage shall be located near the inner surface of the pipe with adequate clear cover.

iv) Water Curing

Pipes manufactured in compliance with this standard shall be water cured for a period of not less than 2 weeks in case of pipes made from ordinary Portland Cement or Portland slag cement or Portland Pozzolana cement or hydrophobic Portland cement, and not less than 1 week in case of pipes made from rapid-hardening Portland cement or 53 grade ordinary Portland cement. Pipes may be water-saturated material or by a system of perforated pipes, mechanical sprinklers, porous hose, or by any other approved method that will keep the pipe moist during the specified curing period. In the case of large pipe projecting partly above the water level, the projected portion shall be kept wet by any suitable means.

5.5 Dimensions

The internal diameter, wall thickness, length of pipes, minimum reinforcements and strength test requirements for different classes of pipes shall be as specified in the respective tables of IS 458. The manufacturer shall inform the **BWSSB** of the effective length of spigot and socket that he is able to supply.

Tolerances

The following tolerances shall be permitted:

Sr. No.		Dimensions	Tolerances
i)		Overall Length	: ± 1% of Standard Length.
ii)		Internal Diameters of Pipes	
	a)	Up to end including 300mm	: ± 3 mm
	b)	Over 300mm and up to and including 600mm	: ± 5 mm
	c)	Over 600mm	: ± 10mm
iii)		Barrel Wall Thickness	
	d)	Up to end including 30mm	:+2mm − 1mm
	e)	Over 300mm and up to and including 50mm	: +3mm − 1.5mm
	f)	Over 50mm and up to and including 65mm	:+4mm − 2mm
	g)	Over 65mm and up to and including 80mm	: +5mm − 2.5mm
	h)	Over 80mm and up to and including 95mm	:+6mm − 3mm
	i)	Over 95mm	: +7mm − 3.5mm

Note:

In case of pipes with flexible rubber ring joints, the tolerance on thickness near the ends will have to be reduced. Near the rubber ring joints, the tolerance on thickness shall be as given in Tables 13 to 19 of IS:458.

5.6 Workmanship and finish

i) Finish

Pipes shall be straight and free from cracks except that craze cracks may be permitted. The ends of the pipes shall be square with their longitudinal axis so that when placed in a straight line in the trench, no opening between ends in contact shall exceed 3 mm in pipes up to 600 mm diameter (inclusive), and 6 mm in pipes larger than 600 mm diameter

The outside and inside surfaces of pipes shall be dense and hard and shall not be coated with cement wash. The inside surface of pipe shall be smooth. For better bond the inner surface of the collar may be finished rough.

The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.

Pipes shall be free from local dents or bulges greater than 3.0 mm in depth and dents and bulges shall not be extending over a length in any direction greater than twice the thickness of barrel.

Pipes may be repaired, if necessary, because of accidental injury during manufacture of handling and shall be accepted if in the opinion of the BWSSB, the repairs are sound and appropriately finished and cured, and the repaired pipe conforms to the requirements of this specification.

ii) Deviation from Straight

The deviation from straight in any pipe throughout its effective length, tested by means of a rigid straight edge as described in IS 3597 shall not exceed, for all diameters, 3 mm for every meter run.

5.7 Tests, sampling, inspection and marking

All RCC S/S Non-pressure pipes are to be tested, for the numbers/scale of sampling and inspected and clearly marked as per the relevant clauses (10, 11 and 12) in IS:458-2003.

5.8 Transport and handling of pipes and other materials

The specification for transport and handling of pipes shall conform to IS: 783-1985 unless otherwise specified.

a) The R.C.C. pipes, base plates, machinehole frames and covers, bolts and nuts, clamps etc., shall be transported by the contractor for laying and construction work at the respective sites of work at his own cost.

b) It is essential to transport, handle and lay the pipes, materials, etc in such a manner as not to cause damage. In lorry/truck shipments, the pipe shall be supported in wide cradles of suitably padded timbers hollowed out on the supporting surface to fit the curvature of pipe, and all chains, calves, or other equipment used for fastening the load shall be carefully padded. For smaller diameter pipes, sand or saw-dust filled bags may be used instead of hollowed out timbers. Pipes shall not be thrown down from the lorries/trucks nor shall that be dragged or rolled along hard surfaces. Slings of canvas or equally nonabrasive materials of suitable width or special attachment shaped to fit the pipe ends shall be used for lifting and lowering pipes so as to eliminate the risk of damage.

c) Great care shall be taken in handling the pipes right from the first operation until they are laid and jointed. The contractor shall be responsible for any loss or damage to the pipes and other materials.

5.9 Permission to lay pipe, concrete

When any portion of the excavation shall have been carried down to the necessary depth, the contractor shall obtain permission from the Engineer before commencing the laying of pipes or concrete.

5.10 Laying and jointing of sewers

a) The specification for laying and jointing of RCC pipes shall conform generally to IS:783-1985 and amendments thereon.

b) These specifications cover the work of laying all RCC pipe lines, underground and above ground, including all civil works required for the same.

c) The Contractor shall manufacture the pipes for a length of maximum 500 m at a time. All these pipes should not be conveyed to the site at a stretch, Contractor shall carefully convey and stack the pipes along the side of the road at every two machinehole lengths only. and this should not affect the traffic and pedestrians.

5.11 Laying and Jointing of R.C.C. pipes

a) Before commencing the work of pipe laying the contractor shall study the longitudinal section and other relevant details of the pipe line for the section/reach concerned. Pedestals/ cradles to be provided for shall be constructed before commencing the pipe laying work in any section, If the pipes are required to be wholly encased in concrete encasement of the pipes shall be done as per the method decided by the Engineer.

b) The contractor should check all pipes, rubber rings and other materials beforehand and satisfy himself and intimate, the department if any defects are noticed or if the quality is found to be not to standard.

c) All pipes shall be carefully handled and lowered into the trench by means of proper methods of handling. The pipes shall be handled by flat rubber belts.

d) Socket should face the opposite to the direction of flow. Pipe shall be normally laid so that spigot end enters the socket face. The socket and spigot ends of the pipe shall be cleared of all extraneous matter especially of clay and grease. Rubber ring shall be clean and dry.

e) All the pipes shall be laid perfectly true both in line and grade specified in the drawings. the rubber rings shall be kept evenly positioned on the spigot groove and when satisfied that the pipe and rubber ring are correctly positioned, the pipe shall be forced/pushed well right home of the full depth of the joint by means of uniformly applied pressure with the aid of a jack or similar appliance. The rubber ring shall conform to 1S:5382-1985. Inside the joint, the two pipe ends shall be in close proximity. Properly fitted temporary wooden stoppers shall be provided and constantly used to close the ends of all in completed pipe lines.

f) Bailing or pumping out of water from trench including shoring, strutting and removing slush while laying, jointing and testing shall be done by the contractor. Caving, sliding, under pinning, floatation are some of the features to be kept in view by the contractor and he shall take all required/necessary special precautions during the course of execution. The contractor shall see that water will not be allowed to accumulate in open trenches, where work is in an incomplete stage. Precautionary works such as blank-flanging the open ends of the pipe line shall be taken up at the contractor's account and no separate payment will be made for the same. Should any section of the pipe line float during the contract period, the entire cost of laying it again to the correct line and level shall be to the account of the contractor.

g) Blank flanges
Blank flanges shall be provided at all ends left unattended for the temporary closure of work. At the end of a day's work, also suitable closures shall invariably be provided at the open end or ends to protect the pipe line from ingress of sub-soil water, mud, muck, debris, dust etc.

h) Wherever pipe laying work is done from two faces and/or has to be done in broken stretches due to any difficulty met with at site, to carry out final connection, the contractor should take all special precautions such as maintaining the levels, grades, alignment keeping in view the length of pipes. If any mistake or error occurs, the contractor shall relay the entire stretch at his cost. Any losses or damages either to pipes

or other material thereupon shall be at the contractor's expense and necessary recoveries shall be made.

i) Precautions against floatation

When pipeline laid underground or above ground in a long narrow cutting gets submerged in water collected in the trench or cutting, it is subjected to an uplift pressure due to buoyancy and is likely to float, completely or partly empty. In the design of pipelines, provision is made to safeguard against floatation by providing sufficient overburden or by providing sufficient dead weight by means of anchor blocks.

In the case of the work extending into the monsoon season, however, special care and precautions are necessary during the progress of work on this account. The work of providing anchor blocks and refilling the trenches to the required level and compacting the same etc. shall always be done as soon as the pipeline has been laid.

The contractor shall see that water will not be allowed to accumulate in open trenches, where work is in an incomplete stage, precautionary work such as blank-flanging the open ends of the pipeline and filling the pipeline with water etc. shall be taken as directed by the Engineer. Such works shall be to the contractor's account and no separate payment will be made for the same. A two metres over burden shall be maintained at all times. Where this overburden is not available, anchor blocks have to be provided.

Protection of pipeline against floatation during the contract period shall be the responsibility of contractor. Should any section of the pipe line float due to their negligence etc, the entire cost of laying it again to the correct line and level shall be to his account.

5.12 Spigot and socket joint (flexible)

The RCC pipe with rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previously laid pipe by means of uniformly applied pressure with the aid of a jack or similar appliance. The RCC pipe shall be of spigot and socket type and rubber ring shall be used, and manufacturer’s instructions shall be deemed to form a part of these Employer’s Requirements. The rubber rings shall be lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

5.13 Cleaning of pipes

As soon as a stretch of RCC pipes has been laid complete from machinehole to machinehole or fora stretch as directed by Engineer, Contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75 mm less in diameter than the internal diameter of the pipes. The open end of an incomplete stretch of pipe line shall be securely closed as may be directed by the Engineer to prevent entry of mud or silt etc.

If as a result of the removal of any obstructions the Engineer considers that damages may have been caused to the pipe lines, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory, contractor shall amend the work and carry out such further tests as required by the Engineer.

It shall also be ascertained by the contractor that each stretch from machinehole to machinehole or the stretch as directed by Engineer is absolutely clear and without any obstruction by means of visual examination of the interior of the pipe line suitably enlightened by projected sunlight or otherwise.

5.14 Testing at work site

After laying and jointing of RCC pipes is completed the pipe line shall be tested at work site as per the following Employer's Requirements and as directed by the Engineer. All equipment for testing at work site shall be supplied and erected by contractor. Water for testing of pipes shall be arranged by him. Damage during testing shall be contractor's responsibility and shall be rectified by him to full satisfaction of the Engineer. Water used for the test shall be removed from pipes and not released to the excavated trenches. The details of testing are given in relevant clauses of IS:458-2003.

SECTION – 6

DOUBLE WALL CORRUGATED PIPES (DWC PIPES)

6.1 General

DWC pipes shall conform to IS 16098 (Part-2). The pipes shall be with non-smooth external and smooth internal surface based on PE structured wall piping system for non-pressure underground sewerage system.

DWC pipes are classified on ring stiffness and shall be designated in the following nominal ring stiffness classes (SN):

a) DN ≤ 500: SN 4, SN 8 or SN 16

b) DN >500: SN 2, SN 4, SN 8 or SN 16m

Under this contract, it is proposed to adopt Class SN8 ring stiffness as per IS 16098 (Part-2).

6.2 Composition of the material

The material from which the pipe is produced shall consist substantially of polyethylene (PE) or polypropylene (PP) to which may be added those additives that are needed to facilitate the manufacture of the pipes as per Tables 1, 2, 3 and 4 of IS 16098 (Part-2) and conforming to requirements of IS16098 (Part-2). In general, (i) base density shall be ≥ 0.930 g/cc in accordance with IS 7328 (ii) Melt flow rate (MFR) ≤ 1.6 g/10 min at 190 ^{0}C and 5 Kg loading mass and shall be as per IS 2530 (iii) Thermal stability (oxidation induction test at 200 ^{0}C)≥ 20 min.

6.3 Rework material

Clean, reprocess able material generated from a manufacturer's own production according to IS 16098 (Part-2) may be used if it is derived from the same raw material as used for the relevant production. Reprocess able material obtained from external sources and recyclable material shall not be used.

6.4 Wall construction designated as type B

Outside Profiled and Inside Smooth Profile Section: A pipe with a smooth internal and profiled external surface forming a finished double walled profile shall be confirming to IS 16098 (Part-2).

6.5 Dimension of pipes and fittings

Diameter of Pipe

The internal diameter (DN/ID) shall be as per Cl No. 6.3.1, Table 5 of IS 16098 (Part-2).

Length of Pipe

The effective length of pipe shall be not less than that specified in Cl No. 6.3.2 and as given in Fig. 2 of IS 16098 (Part-2).

Diameters of Pipes and Spigots of Pipes

The nominal sizes and minimum mean inside diameter for DN-ID series are specified in Cl No. 6.3.3, Table 5 of IS 16098 (Part-2).

The outside diameters of the DN-ID series pipes and spigots intended to have jointing dimensions as pipes according IS 16098 (Part-2) shall comply with the outside diameters and tolerances as specified by the manufacturer.

Diameters and Jointing Dimensions of Sockets and Spigots

Minimum requirement regarding the socket and spigot dimension are specified in Cl No 6.3.4, Table 5 of IS 16098 (Part-2) and Joints with the elastomeric sealing ring shall be positioned in the socket of pipes.

Wall Thickness of Spigot

When the spigot has the same design as the pipe, the wall thickness requirements for the corresponding pipe dimension and construction shall be as per Cl No. 6.3.5 of IS 16098 (Part-2).

Wall thickness of sockets & spigots and joint design requirements

In addition to the minimum required wall thickness of sockets and spigots as per Cl No. 6.3.5 of IS 16098-(Part-2), their ring stiffness, when determined in accordance with Table 10 of IS-16098 shall conform to the requirements of 6.3.5.1.1 of IS 16098 (Part-2).

6.6 Physical characteristics for pipes and fittings

Appearance

The structured outer layer of finished pipes shall be uniformly corrugated. The inner layer shall be smooth and plain. Both layers shall be free from any visual defects such as cracks, blisters, foreign inclusions and any other visual irregularities which may cause harm to its construction integrities. The inner surface may reflect slight shallow undulations and overall shall be as per Cl No.7.1 of IS 16098 (Part-2).

Colour of Finished Pipes

The inner and outer layer of pipes shall be coloured throughout. The outside layer of pipes and fittings should preferably be black, orange, brown or grey and overall shall be as per Cl No.7.1.1 of IS 16098 (Part-2).

Physical Characteristics

When tested in accordance with the test method specified in Table 6 (Physical Characteristics of PE Pipes) using the indicated parameters, the pipes shall have physical characteristics that conform to the requirements given in Table 6 of IS 16098 (Part 2).

6.7 Mechanical characteristics

Mechanical Characteristics of Pipes

The ring stiffness, Impact Strength, Ring flexibility and Creep ratio for the pipes when tested in accordance with the test method specified in Table 10 using the indicated parameters, pipe shall have mechanical characteristics conforming to the requirements given in Table 10 of IS 16098 (Part-2).

Joints

Elastomeric sealing rings used for joining of pipes shall be free from substances that can have a detrimental effect on the pipes. Elastomeric sealing rings shall be in accordance with one of the types (Type 1 to Type 6) of IS 5382 based on the manufacturer's recommendation. A test report or conformity certificate shall be provided from the manufacturer of the sealing ring for conformity to IS 5382.

6.8 Performance requirements

When tested in accordance with the test methods specified in Cl No.9, Table 12, for (i) Tightness of Elastomeric ring seal, (ii) water tightness, resistance to internal pressure, (iii) Resistance to combined temperature cycling and external loading and other parameters as per the Cl No.9 of Table 12, the joints and the system shall have characteristics conforming to the requirements given in Table 12 of IS 16098 (Part-2).

6.9 Sampling, frequency of tests and criteria for conformity

Acceptance Test

Acceptance tests are carried out on sample selected from a lot as per IS in accordance with Table 13 (for pipes) of IS 16098 (Part).

Type Test

Type testing shall be in accordance with Tables 15 of IS 16098 (Part-2), as applicable. All tests are required to be carried out either in an in-house laboratory or at an authorized third party laboratory.

Sampling Lot

All pipes of the same size, same grade and manufactured essentially under similar conditions shall constitute a lot. These pipes shall be selected at random from the lot and in order to ensure the randomness of selection, a random number table shall be used as per IS 4905.

In the absence of a random number table, the procedure given in Table 19 of IS 16098 (Part-2) may be adopted.

Conformance

The lot having satisfied dimensional and visual requirements shall be tested for other requirements with the sample size selected as per Table 20 of IS 16098 from the lot for conformance as per IS 16098(Part-2).

6.10 Marking

General Marking shall be labelled, printed or formed directly on the pipe, in such a way that after storage, weathering and handling the legibility shall be maintained.

Minimum Required Marking Pipes

Each pipe shall be marked at intervals of maximum 3 m, at least once per pipe, with the following information: a) Manufacturer's name/Trade-mark; b) Diameter series, nominal size; c) Stiffness class; d) Material; and e) Lot number/batch number containing information regarding period of manufacture (f) Name of the Client : BWSSB, Bengaluru.

BIS Certification Marking Each pipe shall also be marked with the Standard Mark.

6.11 Transportation, handling, installation and jointing

6.11.1 Transportation

The arrangement of loading the pipes in a telescopic manner is advised, that is, smaller diameters inserted into the next higher sizes of pipes up to the height of 2.5 m in a truck. While loading the pipes into the truck, care should be taken that the spigot/coupler end should be arranged alternatively in the corresponding layer so as to avoid the damage to the coupling/socket-end.

6.11.2 Handling

Following recommendations shall be followed while handling the pipes: a) Pipes shall be smoothly lowered to the ground. b) Pipes should not be dragged against the ground to avoid the damages to the coupler/ pipes. c) 900 mm and larger diameter pipes are carried with slings at two points spaced approximately at 3 m apart. d) For smaller diameters (450 mm to 900 mm, both exclusive) one lift point shall be sufficient. e) For diameters smaller than or equal to 450 mm, manual labour can be used. f) Loading boom or fork lift should not be used directly on or inside pipe.

6.11.3 Pipe Storage at Site

Stockpiling shall be done temporarily on a flat clear area as per IS 16098(Part-2). For avoiding collapse of stacks, wooden posts or blocks shall be used. Stacking shall not be higher than 2.5 m. While stacking, alternate the socket/coupler ends at each row of stacked pipes as per IS 16098 (Part-2).

6.12 Construction methods

6.12.1 Trench Preparation

Dimensions: The width of a sewer trench depends on the soil condition, type of side protection and the working space required at the bottom of trench for smooth installations. Increase in width over required minimum would unduly increase the load on pipe and cost of road restoration. Considering all above factors, the minimum trench width is specified as per Table 21 of IS 16098 (Part-2) and given below shall be adopted.

Minimum Trench Widths

(Clause A-4.1.1)

S. No.	Pipe Diameter (in mm)	Trench Width (in M)
1	75 to 200	0.6
2	250	0.7
3	300	0.8
4	400	0.9
5	600	1.2
6	800	1.3
7	900	1.6
8	1000	1.8
9	1200	2.0

6.12.2 Excavation:

Excavation of sewer trenches shall be in straight lines as much as possible and to the correct depths and gradients as specified in drawings.

Excavated spoils shall not be deposited in the near proximity to prevent the collapse of side of the trenches. The sides of the trench shall, however, be supported by shoring (where necessary) to ensure proper and speedy excavations and concurrently ensuring necessary protections to contiguous structures. In the event, the presence of ground water is likely to cause instability in soil conditions, sump pumping/a well point system/any other suitable dewatering system may be adopted for lowering of water table below the requisite trench bed level. If excavation is made deeper than necessary, the same shall be filled and compacted at the contractor's cost.

6.12.3 Shoring: mild steel sheet piling: As per the site requirement and as directed, the protective shoring works shall be strong enough to prevent caving in of trench walls or subsidence of contiguous areas adjacent to the trench.

6.12.4 Underground services:

The underground public and private utility services exposed due to the excavation shall be effectively supported under the guidance of the owners of such services.

6.12.5 Dewatering: Sewer installation trenches shall be adequately dewatered for the placement of pipe at proper gradient till the pipe is integrated through socket and spigot joint assembly with the already laid segment.

Precautions are to be taken to arrest floating of installed sewer segments against buoyant forces in case of sudden accumulation of water in the trench. The diameter wise minimum cover necessary to counteract the buoyant forces is given in Table 22.

For exceptional cases of higher level of ground water, additional anchoring at equal intervals would be necessary and shall be done as per the contract provisions.

6.12.6 Bedding: For maintenance of sewer slopes the initial backfill envelop with sand or gravel or as per site requirement and as directed would be sufficient. In the event, anchorage becomes imperative the transverse concrete anchorage blocks spaced at suitable interval shall also act as chairs for defining and maintaining the sewer slopes.

Laying:

a) Make the trench reasonably free from ground water and other liquids.

b) Place the pipe on the top level cross-struts of the timber shoring/mild steel sheet piling frame work.

c) Dismantle one/two cross struts and lower the pipes to the immediate lower layer of the cross struts and re-fix the struts immediately (in case of shoring for supporting the trench sides).

d) In the same above manner, reach up to the initial back filling and place the pipe at proper slope.

e) Ensure anchorage, if any, after laying.

Jointing: Various methods for jointing such as spigot and sockets are used.

The moulded socket will have a suitable internal surface with profiles ribs for insertion of the next pipe into it. The socket end of the pipe to be inserted will have corrugated outer layer. On first valley segment of corrugated pipe (destined to be pushed into the coupler socket) one elastomeric rubber ring needs to be placed which is pushed into the coupler socket. This provides sufficient gripping lock and leak proof joint.

For quality connections following steps are to be ensured, failing which the performance aspects will be severely compromised: a) The non-coupler-socket end needs to be clear and free from any foreign material. b) Use a clean rag or brush to lubricate the non-coupler socket end with lubricant. (c) Clean and lubricate the coupler end (spigot) of the pipe to be laid in similar manner. d) Lubricate the exposed gasket in the same manner with pipe lubricant. e) Keep the lubricated non-coupler end free from dirt, backfill material, and foreign matter so that the joint integrity is not compromised. f) Push the coupler/socket into non-coupler/spigot and align properly. Always push coupler end into non-coupler end. For smaller diameter pipes simple manual insertion shall be sufficient. In every methodology, it should be ensured that the coupler end is adequately ‘homed’ within non-coupler end to ensure installation and tight joining seal. Therefore, prior to insertion always place a homing mark on appropriate corrugation of the noncoupler end.

6.12.7 Construction of Backfill Envelope and Backfilling of the Trenches:

These pipes and well compacted backfill envelope work together to support soil and traffic load. In general, material used for construction of backfill envelop around the pipe comprises the following: a) Initial backfill; b) Side fill; and c) Top backfill.

The material for backfill envelop shall be as per the structural design of flexible buried conduit. It can be the same material that were removed in the course of excavation or it can be fine sand/course sand/gravel or as per site requirement and as directed. The remaining portion of backfilling shall be the materials that were removed in the course of excavation. These materials shall consist of clean earth and shall be free from large clod or stone above 75 mm, ashes, refuse and other injurious materials.

After completion of laying of pipes, etc, first the backfill envelope shall be constructed as per design around pipe. Voids must be eliminated by knifing under and around pipe or by some other technique and compacted with necessary watering, either by hand rammers or compactors to a possible maximum level of proctor density. Backfilling shall start only after ensuring the water tightness test of joints for the concerned sewer segments. However, partial filling may be done keeping the joints open. Precautions shall be taken against floatation as per the specified methodology and the minimum required cover.

6.13 List of approved makes

The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering Pipe/equipment. Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired.

In order to achieve standardization for appearance, operation, maintenance and manufacturer's service, to the greatest extent possible, shall be the end products of one (1) manufacturer.

	Pipes	**Makes of Equipment**
	DWC Pipes	Prince Piping Systems, Mumbai.
		Gemini Pipes, Jaipur, Rajasthan, India
		Alom Poly Extrusions Ltd, Kolkata, West Bengal

Note-1: In the event that the contractor wishes to propose alternate vendor for the DWC pipes mentioned above, he shall submit the following during detailed engineering:

1) Demonstrate that the proposed makes are “Superior / Equivalent” to the approved makes.
2) Submit quality certificates that the Pipes/equipment adheres to the specifications as mentioned in this section.
3) Submit product brochures for the proposed equipment.
4) At least 10 successful individual installations/Sewer laying of similar size as per this contract.
5) Manufacturer to provide full contact information for each reference as part of technical bid.

SECTION-7

DUCTILE IRON PIPES (DI)

7.1 Manufacture of Pipe

DI pipes (Class K7 & K9) and fittings (Class K12) shall be in accordance with IS: 8329 and IS: 9523. Pipes and fittings shall be procured from reputed manufacturers with Engineer's approval. Engineer shall at all reasonable times have free access to the place where the pipes and fittings are manufactured for the purpose of examining and testing the pipes and fittings and for witnessing the test and manufacturing. For the gravity sewers DI pipes of class K7 shall be used and for the pumping mains DI K-9 Class pipes shall be used.

All tests specified either in this specification or in the relevant Indian Standards specified above shall be performed by the supplier/Contractor at his own cost and in presence of Engineer if desired. For this, sufficient notice before testing of the pipes and fittings shall be given to Engineer.

If the test is found unsatisfactory, Engineer may reject any or all pipes and fittings of that lot. The decision of Engineer in this matter shall be final and binding on the Contractor and not subject to any arbitration or appeal.

The pipes and fittings shall be stripped, with all precautions necessary to avoid warping or shrinking defects. The pipes and fittings shall be free from defects. Any defect in pipes and fittings in the opinion of Engineer shall be rejected and shall be replaced by new one.

In the case of spigot and socket pipes and fittings the socket shall be without the centre ring.

In the case of flanged pipes, the flanges shall be at the right angles to the axis of the pipe and machined on face. The bolt holes shall be drilled and located symmetrically off the centerline. The bolt hole shall be concentric with the bore and bolt holes equally spaced. The flanges shall be integrally cast with the pipes and fittings and the two flanges of the pipe shall be correctly aligned.

7.2 Materials

The materials used in the manufacture of pipes and fittings shall comply with requirements specified in IS: 8329 and IS: 9523.

7.3 Dimensions and tolerances

The internal diameter, thickness and length of barrel, dimensions of pipes and fittings shall be as per relevant tables of IS: 8329/IS: 9523 for different class of pipes and fittings. Each pipe shall be of uniform thickness throughout its length.

The tolerances for pipes and fittings regarding dimensions, mass, quality and deviations from straight line in case of pipes shall be as per IS: 8329/IS: 9523.

7.4 Testing of pipes during manufacture

(a) Mechanical Tests

Mechanical tests shall be carried out during manufacture of pipes and fittings as specified in IS: 8329 / IS: 9523. The frequency and sampling of tests for each batch of pipes shall be in accordance with IS: 8329. The test results so obtained for all the pipes and fittings of different

sizes shall be submitted to Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per IS: 8329/IS: 9523.

(b) Brinell Hardness Test

For checking the Brinell hardness, the test shall be carried out on the test ring or bars cut from the pipes used for the ring test and tensile test in accordance with IS: 1500. The test shall comply with the requirements specified in IS: 1500/IS: 8329.

(c) Retests

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements, the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

(d) Hydrostatic Test

For hydrostatic test at works, the pipes and fittings shall be kept under test pressure as specified in IS: 8329 / IS: 9523 for a period of minimum 15 seconds, during which the pipes shall be struck moderately with a 700 g hammer for conformation of satisfactory sound. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. The hydrostatic test shall be conducted before surface coating and lining.

7.5 Laying of the pipe

Laying of DI pipes shall conform to the Code of practice of IS: 12288. Pipes shall be laid underground with a minimum earth cover of 1m. Pipes shall be generally laid in sections of 300 m each. Laying of pipes shall be as per Standard Specifications for Procurement of Project Works. All pipes, fittings and material shall be tested and approved by the Engineer before being laid. Any pipes, fittings or material placed before they are tested and approved shall be removed and replaced with tested and approved material. Before laying the pipe, necessary bedding shall be provided wherever required. Polyethylene sleeves wounded pipes shall be used for water logged areas as per specification and as directed by the Engineer.

7.6 Jointing of pipes

(a) General

Jointing of DI pipes and fittings shall be done as per IS: 12288 and manufacturer's recommendations. After jointing, extraneous material, if any, shall be removed from the inside of the pipe. Rubber sealing rings/gaskets used for jointing shall conform to IS: 638, IS: 12820 and IS: 5382.

(b) Spigot and Socket joints

These shall have sockets, which are integral with the pipe and incorporate an elastomeric rubber ring gasket conforming to IS: 12820.

The gaskets/sealant used for joints shall be suitable for water conveyance. In jointing DI pipes and fittings, the Contractor shall take into account the manufacturer's recommendations as to the methods and equipment to be used in assembling the joints. In particular the Contractor shall ensure that the spigot end of the pipe to be jointed is smooth and has been properly

chamfered, so that the rubber ring as per IS: 12820 and IS: 5382 is correctly positioned in line, before the joint is made. The rubber rings and any recommended lubricant shall be obtained only through the pipe, supplier or as otherwise directed by the Engineer.

(c) Gaskets for Flanges

All gaskets used between flanges of pipes shall be of natural rubber conforming to IS: 638 of thickness 3 mm suitable for clear water conveyance and as specified by manufacturer.

(d) Flanged joints

These shall be of PN 1.0 rating and shall comply with dimensions and drilling details as specified in IS: 8329. These shall have isolation gaskets between the flanges, isolation sleeves around all bolts and isolation washers under all bolt heads and nuts. All material shall be supplied by a reputed manufacturer and shall be approved by the Engineer.

Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively. The recommended bolting torque to be followed for assembling flanges shall be as specified in manufacturer's instructions. The practice of fully tightening the bolts one after another is highly undesirable. The bolts shall be of mild steel unless otherwise specified. They shall be coated with coal tar epoxy coating after tightening.

7.7 Coatings

(a) General

Unless otherwise specified, DI pipes and fittings shall be coated with Bitumen in accordance with relevant IS specifications. All buried DI pipes and fittings shall also have factory or site applied polythene sleeving. Coating shall not be applied to pipe and fittings unless its surface is clean, dry and free from rust. Pipe coatings shall be inspected at site and any damage or defective areas shall be made good to the satisfaction of the Engineer.

(b) Bitumen coating

Bitumen coating shall be of normal thickness of 75 microns unless otherwise specified. It shall be cold applied compound complying with the requirements of relevant Indian standards, suitable for tropical climates, factory applied in accordance with the manufacturer's instructions.

Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe.

(c) Cement mortar lining

All pipes and fittings shall be internally lined with cement mortar in accordance with IS: 11906. Cement mortar lining shall be applied at the factory in conformance with the above-mentioned standards. The cement used shall be High Alumina Cement. No admixtures in the mortar shall be used without the approval of the Engineer.

Pipe linings shall be inspected on site and any damage or defective areas shall be made good to the satisfaction of the Engineer.

Lining shall be uniform in thickness all along the pipe. The minimum thickness of factory applied cement mortar lining shall be as per IS: 11906.

(d) Marking

Marking shall be done as per IS: 8329 and IS: 9523 or any other relevant IS codes.

7.8 Carting & handling

Pipes and fittings/specials shall be transported from the factory to the work sites at places along the alignment of pipeline as approved by Engineer in lengths not more than the length of the transporting vehicle. Contractor shall be responsible for the safety of pipes and fittings/specials in transit, loading/unloading. Every care shall be exercised in handling pipes and fittings/specials to avoid damage. While unloading, the pipes and fittings/specials shall not be thrown down from the truck on to hard surfaces. They should be unloaded on timber skids with steadying ropes and / or by any other approved means. Padding shall be provided between coated pipes, fittings/specials and timber skids to avoid damage to the coating. Suitable gaps between pipes should be left at intervals in order to permit access from one side to the other. As far as possible, pipes shall be unloaded on one side of the trench only. The pipes shall be checked for any visible damage (such as broken edges, cracking or spoiling of pipe) while unloading and shall be sorted out for replacement. Any pipe, which shows damage in the opinion of Engineer, shall be discarded and replaced by new one without extra cost. Dragging of pipes and fitting/specials along road or pipeline alignment shall be prohibited.

7.9 Methods of measurement for sewerage system

1. For manufacture, supply and delivery of pipes, measurement shall be taken for actual number of pipes multiplied by the standard length.
2. Laying and jointing of pipes and specials and valves will be measured in linear meters along the centre line of the pipes actually laid, jointed and tested and will be limited to the number of pipes x standard length + part length of pipe if any including specials and work is including the cost of rubber ring.

SECTION – 8

ACCEPTANCE TESTS

8.1 Check for Obstruction

a. As soon as a stretch of pipes whether of RCC Pipes or DWC or DI Pipes has been laid Complete from machinehole to machinehole , the Contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75 mm less in diameter than the internal diameter of the pipes. The open end of an incomplete stretch of pipe line shall be securely closed as may be directed by the Engineer to prevent entry of mud or silt etc.

b. If as a result of the removal of any obstruction the Engineer considers that damages may have been caused to the pipe lines, he shall be entitled to order the length to be retested at the expense of the Contractor. Should such retest prove unsatisfactory the Contractor shall at his own expense amend the work and carry out such further tests as are required by the Engineer.

c. It shall also be ascertained by the Contractors that each stretch from machinehole to machinehole is absolutely clear and without any obstruction by means of visual examination of the interior of the pipe line.

8.2 Hydraulic Testing of Sewers

Immediately after the test with the double disc or cylinder as mentioned above has been completed and any defects thereby disclosed have been made good, the Contractor shall prove the joints of the stretch of under-ground pipes are water tight.

Each section of sewer shall be tested for water tightness preferably between Machineholes. To prevent change in alignment and disturbance after the pipes have been laid, it is desirable to backfill the pipes up to the top keeping at least 90 cm length of the pipe open at the joints. However, this may not be feasible in the case of pipes of shorter length, such as stoneware and RCC pipes. With concrete encasement or concrete cradle, partial covering of the pipe is not necessary.

If it is necessary that the pipelines are filled with water before commissioning the application of pressure to allow for the absorption by pipe wall as per relevant IS standards.

The Sewers are tested by plugging the upper end with a provision for an air outlet pipe with stop cock. The water is filled through a funnel connected at the lower end provided with a plug. After the air has been expelled through tile air outlet, the stop cock is closed and water level in the funnel is raised to 1.5 m above the invert at the upper end. Water level in the funnel is noted after 30 minutes and the quantity of water required is measured at an interval of 10 minutes to restore the original water level in the funnel. The pipe line under pressure is then inspected while tile funnel is still in position. There shall not be any leaks in the pipe or the joints (small sweating on tile pipe surface is permitted), any sewer or part there of that does not meet the test shall be emptied and repaired or re-laid as required and tested again. The leakage or quantity of water to be supplied to maintain the test pressure during the period of 10 minutes shall not exceed 0.2 litres/mm dia, of pipes per kilometre length per day. Water and other accessories required for testing shall be to the account of the contractor. In case of DI pumping/rising mains the hydro testing of the pipes shall be carried out as per IS 8329 provisions.

8.3 Testing of Machineholes

The entire height of the machinehole shall be tested for water tightness by closing both the incoming and outgoing ends of the sewer and filling the machinehole with water. A drop in water level of not more than 50 mm per 24 hours shall be permitted. In case of high sub-soil water, it should be ensured that there is no leakage of ground water into the machinehole by observing the machinehole for 24 hours after emptying it.

Water and other accessories required for testing shall be arranged by the contractor at his own cost.

SECTION 9

TECHNICAL SPECIFICATIONS FOR TRENCHLESS TECHNOLOGY

9.1 General Specification

These specifications are intended for general description of quality and workmanship of materials and finished work. They are not intended to cover minute details. The work shall be executed in accordance with best modern practices and using appropriate techniques of trenchless technology as necessary considering the physical and geotechnical site conditions subject to approval of the Engineer.

The quantities specified in the tender are only approximate and may change depending upon the actual site conditions and the work by trenchless technology shall have to be carried out at quoted rates only.

Contractor's obligations

The scope of this component of the contract is ***"design and build"*** pipelines laid by trenchless technology works like pipe jacking/ pushing, auger boring or micro tunnelling and shall cover all equipment, designs, preparatory works, safety measures, testing and commissioning etc necessary for trenchless process. If the Contractor intends to use any other trenchless technique, it shall be with prior approval of the Engineer and at no extra cost of whatsoever nature to the Employer. The Contractor may request the Engineer for approval to a specific trenchless technique but Engineer's decision shall be final and binding. However, the Contractor shall be solely responsible for adequacy and safety of any of the techniques to be used. The Engineer reserves right to consider such alternative trenchless techniques.

The clauses in this section are meant to provide general guidelines and compliance requirements to the Contractor. It does not however relieve the Contractor from taking every other steps and precautions as deemed necessary to complete the installation of the pipelines successfully within the specified contract period and the amount.

The objective of the work is to provide and lay sewer lines meeting the hydraulic requirements for future and fulfilling the structural and serviceability requirements.

The Contractor's shall note that the alignment of the proposed works is in vicinity or affected by-

- Highways including existing CC road pavement and major junctions of roads
- Railroads including tracks on high embankments
- Crossing of major nalla/ drains/ water courses or in close vicinity of water bodies
- Laying of sewers in congested areas where traffic diversion is not permitted

Furthermore, the consideration that a method permitted as a suitable method of installing the sewers by trenchless technology shall not relieve the Contractor in any way from his prima facie obligation and responsibility under the contract to successfully install the pipelines without causing interruptions to traffic or inconveniencing citizens or road users and within the specified contract period and contract amount.

The Contractor's rates in the Bill of Quantities shall be deemed to be for installing the pipelines successfully including all appurtenant and/or ancillary works within the specified contract period regardless of the method.
It shall be obligatory for the Contractors to carry out geotechnical and other investigations including buried services detection by appropriate equipment and satisfy themselves and the Engineer of the adequacy of their testing.

The Employer / Engineer shall not be responsible for any changes in method or equipment necessitated during execution of the work and it shall be contractor's sole responsibility to ensure deployment of proper method and equipment for the work.

The Contractor shall, on his own accord collect information or conduct investigations about likely geotechnical conditions at the site. Any risks assumed by the applicant by solely depending on his current knowledge of the site of the information currently available on the geotechnical conditions, buried services, any physical obstructions shall be entirely his own and he shall be solely and fully responsible for any consequential expenses arising as a result of the risk he assumed. He shall not resort to any compensation claim under the contract for differing ground condition that he may encounter as a result of assuming the risk.

The extent and scope of the geotechnical and other investigations along the pipeline route would depend on the type of the equipment and systems that he proposes to use in the project.

The applicant shall ensure that the Trenchless Technology system shall successfully excavate in wide ranging ground conditions, from soft ground, sandy/ silty strata to hard rock strata or strata with boulder or high water table etc. likely to be encountered at the sites. For soft and slushy grounds the contractor shall adopt appropriate ground improvement method to suit the construction method as well as to ensure long term stability of pipeline laid during its lifespan.

Scope of Work

The scope of work under this component shall include but not be limited to the following :

a. Thorough geotechnical investigations needed for ground assessment and sewer laying using trenchless work.
b. Detection and mapping of buried services in vicinity of the proposed alignment and providing a diversion or relocation plan. Temporary diversion of such utilities in consultation with the concerned owners and the Engineer of the Contract shall be at risk and cost of the Contractor.
c. Arrange for permissions from various authorities including railways and pay necessary charges which shall be reimbursed by the Employer at actuals.
d. Construction of shafts/ insertion or access pits for the proposed method using appropriate excavation technology such as well sinking or sheet piling or trench box shoring or any other type of shoring system with detailed design including leaving any type of shoring system in trenches as necessary.
e. Design, manufacture and supply of appropriate type of pipes suitable for the technique to be adopted including RCC Jacking pipes conforming to JSWAS A-2/ A-6, HDPE pipes conforming to IS 14333, DWC pipes conforming to IS 16098 Part 1 and 2, MS pipes for manual pipe pushing/ jacking conforming to IS 3589as acceptable to the Engineer. The scope shall also include all types of carrier pipes besides the sleeve pipes.
f. Construction of Machineholes and appurtenances as per the specification requirements or as directed by the Engineer.
g. Planning, Detailed Design and construction of interconnection with existing system for connection of flows to the newly laid lines.

h. Excavation as necessary apart from construction of shafts
i. Backfilling of excavated trenches and reinstatement of surfaces
j. Rectification of any damage caused to adjoining structures
k. Management of excavated material including disposal of surplus material in environmentally friendly manner as directed
l. All ancillary and enabling works needed for the main works as mentioned above
m. Submission of as-built drawings (Soft copy and hard copies as required by the Engineer)

9.2 Selection of trenchless technique

The technique of trenchless technology to be adopted shall take in to account the physical site conditions, geotechnical conditions, arrangement of pipes, obligatory requirement of various authorities etc as mentioned below.

General approach for selection of trenchless technique shall be as under-

A. Application-
    a. Sewer line carrying domestic sewage
B. Function
    a. Gravity
C. Arrangement of pipes
    a. In casing- Casing + Carrier
    b. Direct carrier
D. Dimensional details
    a. Diameter (Jacking and Carrier)
    b. Depth of installation
    c. Obligatory length of single drive
    d. Limiting length of drive
E. Geotechnical aspects
    a. Soft ground (Clayey)
    b. Sandy/ silty
    c. Murum
    d. Soft/ Weathered rock
    e. Hard rock
F. Physical conditions
    a. Along a narrow road
    b. Along a wider road with heavy traffic
    c. Railway crossing
    d. Highway crossing/ Major Access Controlled Roads
    e. River/ Nalla/ Drains/ Water course crossing

G. Material of casing and carrier pipe
    a. RCC/DI
    b. HDPE/DWS
        i. Solid Wall
        ii. Double Wall
    c. MS
H. Arrangement desired
    a. Carrier and Sleeve
    b. Direct installation

The Engineer shall, in general, consider the above aspects for considering appropriate trenchless at a particular stretch of the work.

Trenchless techniques considered suitable are -

A. Pipe pushing/ Jacking
B. Auger boring
C. Micro tunneling
D. Any other method such as HDD

The Contractor may request for approval of the Engineer to any other technique but the Engineer's decision shall be final and binding on the Contractor.

9.3 Terminology and general description

Definitions

For the purpose of this contract document, the technical terms pertaining to micro tunnelling works and their functional details are defined below. The definitions herein are meant only as guidelines. If other (or new) definitions or technical terms are used by the Contractor in his submittals, they shall be clearly defined by him.

Micro tunnelling

Micro tunnelling is a process of accurately excavating, tunnels for installing underground pipelines, using steerable laser guided remote controlled shields of required diameters. Micro tunnelling permits accurate monitoring and adjusting of the alignment and level (either manually or automatically) as the excavation proceeds.
It is an art of accurately installing pipelines (usually 450mm diameter and above which may be up to 2400mm or even beyond), without digging up of ground surface, using a laser guided remote controlled shields for tunnel boring using slurry or EPB shields and pipe jacking technique for lining the bore with the product pipe.

The process of installing a pipeline by micro tunneling and pipe jacking system comprises five parts:-
(a) Micro tunnel boring machine (Shields)

(b) Automated spoil removal system
(c) Jacking system for pushing the jacking pipe and later on carrier pipe as needed
(d) Guidance system to guide the tunnel excavation
(e) Remote control system to operate the shield and other paraphernalia equipment.

Manual Pipe jacking

It is a process of lining an underground bore formed by manual excavation under a shield or other means and pushing specially designed jacking pipes (reinforced concrete or other pipes) simultaneously into the excavated tunnel bore, from a shaft (known as jacking shaft) to another shaft (known as receiving shaft).

Auger boring

Auger boring is a process of accurately excavating through ground using flights of augers for spoil removal and drill heads catering to various types of soils ranging from soft ground to rock for installing underground pipelines, using steerable guided remote controlled shields of required diameters generally 450mm to 1000mm. The method may involve pipe installation using single stage or multi stage operation using flight of augers and sections of the pipe to be installed.
A type of directional and guided boring machine, which uses auger flights to remove the spoil through separate casing placed through the product pipeline.
In this system, the excavated materials are continuously removed by an encased screw conveyor attachment connected to the rear of the tunnel cutter face. By controlling the speed of the screw augur and the outlet of the conveyor at the spoil discharge point, the excavated soil at the tunnel face can be kept under a desired balancing pressure to support the tunnel face.

Micro Tunnel Boring Machine (shield)

It is mechanized, steerable mini boring machine (or shield) equipped with suitable cutter head in front to excavate smaller diameter tunnels under controlled conditions in which the tunnel face and ground water pressure are continuously balanced as the shield excavates and moves forward. The operation and steering of the shield are remotely controlled with the aid of laser and/or CCTV system.
There are three systems available for the balancing the face pressure below:

Earth Pressure Balance (EPB) system

Earth Pressure Balance (EPB) is a system in which mechanical pressure is applied to the material at the face and controlled to provide the correct counterbalance to earth pressures in order to prevent heave or subsidence. The system allows excavation of the materials under controlled conditions so that no free flow of soil or ground water is permitted at the tunnel face. The spoil removal rate and the speed of the shield advancement are thus controlled either fully or semi-automatically.

Slurry Pressure Balance (SPB) system

It involves balancing the face pressure using a mechanical tunnelling shield with closed face, which employs hydraulic means for removing the excavated material, and balances the ground water pressure by mixing the excavated stuff with water to form slurry. In this system, the excavated materials is continuously mixed with water and or bentonite to convert into slurry and kept under a desired balancing pressure to support the tunnel face. The slurry is pumped to the ground surface where the solids are separated for disposal and the water is pumped back to the tunnel face for further utilization.

Automated spoil removal system

This system conveys the excavated spoil from the tunnel face to the ground surface for disposal. The spoil removal rate and the speed of the shield are fully or semi-automatically controlled in such a way to achieve minimal heave or settlement. The common systems available for the conveyance of the spoil and they are slurry system and augur system.

Slurry system employs hydraulic means for removing the excavated material by mixing the excavated stuff with water to form slurry. In this system, the excavated materials is continuously mixed with water and or bentonite to convert into slurry which is pumped to the slurry separation tank at ground level where solids can be separated from slurry and water reused.

In case of EPB shields, the removal of spoil is through a method which used balancing force of the excavated soil and the soil is generally removed using augers or belt conveyors.

Jacking System

The jacking system comprise high thrust hydraulic jacks mounted in a jacking frame capable of exerting the required jacking force against a purpose-built thrust wall to push the pipes and the shield forward through the ground. The jacking force is transferred evenly to the jacking pipe through a push ring connected to the pipe.

Guidance System

The guidance system comprises a laser beam device or a theodolite with laser beam attachment or visual guidance system such as CCTV. The device is installed in the jacking shaft and the beam is set to the desired level, gradient and alignment.

Some machines have photo sensitive cells on the target panel located at the rear of the shield which converts the laser position into digital data. The data are then electronically transmitted to the operator's control panel where digital readout of the location can be made. Some modern shields have built-in capabilities to use the digital data and automatically make necessary steering adjustments to guide the machine to the true alignment and level.

The contractor shall submit complete details of the guidance system he proposes to use and shall incorporate appropriate check points and hold points in the Quality Assurance Manual that he shall implement in the contract. The system shall provide continuous recording of the details of drive capturing various parameters not limited to the horizontal alignment or x & y coordinates, vertical alignment, roll, pitch, torque, jacking force, laser positions, jack positions, temperature of hydraulic system, slurry/ muck flow rates, etc. and a detailed printout of such parameters shall be submitted to the Engineer at the end of every day.
The laser source or theodolite shall be firmly supported in the jacking pit so that it is independent of any movement that may take place during the micro tunnelling and jacking operation.

Remote Control System

All micro tunnelling systems rely on remote-control capability. The control system monitors and controls the steering of the shield, spoil removal system (slurry or augur or vacuum), jacking system and guidance system. The system operation varies from totally manual to fully automatic. The remote control system is usually housed in portable control cabin.

The control cabin shall be located near to the jacking pit so that the operator can visually monitor the activities in the pit. Where it is not possible to locate the control cabin near to the pit due to space limitations, a CCTV camera system shall be set up in the pit to allow the operator to monitor the activities in the pit.

For the manual operating system, the operator's skill is very crucial for a successful completion of the project. The operator shall have experience of at least 10 years of piloting micro tunnelling equipment of which in driving.

The operator shall monitor all the information and continuously feed into the control panel as necessary. He shall be alert at all time and shall observe the crew's activities and other site activities, evaluate the information and make appropriate operational decisions. The information relayed back to the operator shall be audible, tactile and visual as The MTBM shall have facility to transmit sounds and vibrations from the excavation face to the operators to enable him to make appropriate operational decisions. Notwithstanding the ability of the equipment to keep automatic drive records, the operator shall monitor and keep record of line and grade of the machine, cutter head torque, thrust, RPM, steering pressures, slurry flow rate, pressures of slurry systems and rate of advancement.

In fully automated system, the machine acquires and evaluates the information and select the operational steps for automatic steering of MTBM. The information collected shall be logged in a microprocessor to obtain a printout as necessary.

The contractor shall incorporate check points and hold points for the guidance control system in the Quality Assurance System that he shall implement in the contract.

Supplementary systems

The supplementary system required for micro tunnelling and pipe jacking operation shall include Muck disposal system, pipe handling systems, pipe lubrication system, Grouting system, Guide rails, and Entrance and Exit rings and power supply systems.

Jacking shaft (or Jacking Pit)

Jacking Shaft is an important temporary structure from where jacking operation is performed. The shaft is usually rectangular or circular in shape and built using liner plates, sheet piles or timber shoring. The size of the shaft shall be such that it is capable of accommodating the jacking equipment (and also the shield), jacking pipe, thrust and entrance wall, Laser source and other paraphernalia or enable construction of machinehole or chamber as needed. This may correspond to the position of the Machineholes and the size and shape shall take cognizance of the same. The requirement for jacking shaft shall take full cognizance of the available working space and intended equipment. If it is intended to have a common shaft for both the drives, the size of shaft shall be selected accordingly.

Receiving shaft (Receiving pit)

A purpose-built temporary structure to receive and remove the tunnelling shield after its completion of a tunnel drive. The shaft is also rectangular or circular in shape and smaller than the jacking shaft. The size shall be sufficient enough to accommodate the tunnelling shield when it emerges into shaft after completion of a tunnel drive or construction of machinehole or chamber as needed.

Footprint

The footprint of a micro tunnel drive shall be taken as the net area occupied by the jacking or receiving shafts. The size of the footprint depends on many factors including the microtunnelling system and the length of jacking pipe used. The footprint requirement shall be an important factor, especially in congested and narrow roads when selecting the microtunnelling system for a project.

Thrust wall

Thrust wall is a temporary concrete or steel structure built within the jacking shaft to transfer the jacking force to the ground during jacking operation. The jacking shafts may often have more than a single thrust wall and each thrust wall shall be perpendicular and square to the pipeline to be jacked. The thrust walls shall be in good contact with the soils behind so that wall can transmit the jacking force effectively to the ground without affecting the shoring system.
All the affected thrust wall shall be demolished fully or partly after completion of jacking operation involving in that wall.

Entrance Ring

A steel flange fitted with a rubber seal (a 10mm to 20mm thick circular rubber gasket whose outside diameter is same as that of the steel flange and the inside diameter is smaller than that of the jacking pipe) installed perpendicular to the pipeline at the entrance. The purpose of the rubber seal is to prevent the slurry or ground water from entering into the shaft through the pipe entrance. The entrance seal shall be capable of withstanding anticipated pressure of the pressurized slurry with bentonite and/or the hydrostatic pressure

Exit Ring

This is similar to the entrance ring except that the internal diameter of the rubber seal is much smaller than that of the jacking pipe and is installed to prevent the slurry or ground water from escaping the tunnelling machine when it emerges at the receiving shaft. The exit seal shall be capable of withstanding anticipated pressure of the pressurized slurry with bentonite and/or the hydrostatic pressure.

Guide Rails (or Jacking Table or Frame)

To facilitate placing of the micro tunnelling machine and pipes in the jacking shaft, a set of guide rails are installed in position on the base of the shaft. The guide rail assembly (also known as jacking table/ frame) shall be carefully set up in the shaft to correct alignment and gradient so that the pipe when placed on it stays in line with and square to the pipeline alignment. The guide rail assembly shall be independent of the thrust wall so that it is not disturbed due to jacking force exerted onto the thrust wall.

Thrust Pressure Plate

The thrust pressure plate is usually a 50mm or 100mm thick steel plate installed between the jacks assembly and the thrust wall. The pressure plate enables the concentrated jacking load from the jacks to be transmitted evenly to the thrust wall,

Intermediate Jacking Station

For longer distance jacking, intermediate jacking stations, comprising a telescopic type jacking pipe assembly (usually made of steel), are used. A set of inter jacks and push ring are installed around the inner side of the female pipe of the telescopic pipe assembly. The intermediate jacking pipe assembly shall be installed at appropriate point and jacked-in along with the other jacking pipes. The contractor must plan for number of intermediate jacks as necessary for successful completion of the drive without overstressing the jacking pipes.

Cutter head (Micro tunnelling)

It is usually a disc shaped wheel mounted on the face of the micro tunnelling machine (shield) and is driven by hydraulic or electrical motor, located within the machine. The excavation capabilities of a micro tunnelling machine depend very much on the type of cutter head used, its speed of rotation and average and peak torque etc.

Different types of cutter head configuration are used in micro tunnelling machines to suit the type and nature of the ground through which tunnelling is to be carried out. For example, in soft ground tunnelling the cutter head shall have bits arranged in such a way to cleave and guide the soil into a chamber behind the cutter head through the openings provided in the cutter wheel.
In the case of rock or hard ground tunnelling the cutter head shall be equipped with suitable bits, roller bits or disc cutters for effective transfer of cutting energy to rock. In case of clay/ sand or mixed ground conditions, the cutter head shall be designed to suit the geotechnical conditions involving the site.

Cutter head (Auger boring)

In case of auger boring in rocky strata, the equipment shall be fitted with appropriate tools like “Front Steer” or “Pilot Tube System- RVS” or active and passive hole openers as necessary for successfully drilling in the anticipated ground.

Jacking Ring

Jacking ring or thrust plate is a purpose made structural fitting which shall be installed between the jacking assembly and the jacking pipe to transfer the point loads from the individual jacks into evenly distributed jacking force to the pipes being jacked. The ring shall be fabricated and machined, if necessary, so that it fits exactly onto end of the jacking pipe.

9.4 Performance Requirements

9.4.1 Design Life

For the purpose of designing the pipelines and the associated structures, the design life shall not be less than 60 years. The materials incorporated in the works and the workmanship shall be of required quality to sustain the specified life span.

9.4.2 Level and Alignment Accuracy

The pipes shall be installed into place, true to line and level. The maximum tolerance allowable in the displacement of the center line of the laid pipe from the design center line is 50 mm in the horizontal plane and 25mm in the vertical plane but there shall be no back-fall at any point.

There shall be provision to prevent the relative movement between pipes at the joints by the use of steel gaiters or other approved methods during jacking operation. A packing piece of compressible

material shall be provided at each joint and shall be securely held before the pipes are lowered into the thrust pit. Details of proposals shall be submitted to the Engineer for approval.

The Contractor shall be responsible for ensuring accuracy of pipe laying by micro tunnelling and shall take due cognizance of the ground conditions.

9.4.3 Limits on ground settlement and upheaval

The trenchless technology method adopted by the Contractor shall be such that the initial surface settlement measured directly above the front face of the shield or boring equipment during the tunnelling/ boring/ pipe jacking operations does not exceed 15mm and the maximum surface settlement after the tail voids are grouted shall not exceed 25mm. The affected ground and the structures shall be subsequently reinstated to their original condition at Contractor's risk and cost.

For the sections of pipeline crossing under nallas, roads and railways the Contractor shall be required to incorporate in his tunnelling method measures to arrest the expected settlements so as to safeguard the integrity of the road surfaces and collapse of nalla bed. The Contractor shall ensure that the traffic flow along the roads is not affected in any way as a consequence of his work.

In case of the works of laying sewers across any nallas or water courses, it may be necessary to provide kentledge to prevent upheaval or escape of slurry or to ensure proper overburden above the crown of the pipe being laid by microtunnelling. The contractor shall ensure that proper arrangements for non-disruption of the flow through such nalla or water course are made by adopting appropriate measures approved by the Engineer. Such kentledge in drains shall be removed and waterway cleared after completion of the work. No extra payment shall be admissible for provision and removal of such kentledge.

9.4.4 Providing temporary access to the jacking or receiving shafts

The alignment/ placement of Machineholes and shafts might have to be taken outside the carriageway in to kutcha portion.

Where it is seen that the locations of jacking and reception shafts do not have direct access from roads for taking construction plant equipment, the Contractor may have to provide temporary access including access over barges/ boats and also to erect marooned barges at the site of the reception shafts. Any temporary arrangement shall be subsequently removed, and the site conditions restored to their original state upon completion of the work.

9.4.5 Limitation on Footprint and weight of machine

The Contractor shall be deemed to have visited the sites and carefully planned and located the shafts at convenient points so as to minimize the working area to be occupied by the footprint. The contractor shall be deemed to have allowed for such site constraints and measures required, including working in the night and construction of decking over the shafts, provision of access roads for construction plant and machinery, to allow the traffic to flow, in his rates. He shall take the site constraints and restrictions into consideration when selecting the trenchless technology system. It is necessary to pay close attention to the ground conditions, bearing capacity of the ground at appropriate level and select the head and equipment accordingly. The weight of the equipment selected should be such as to eliminate equipment settlement during driving the tunnel and installation the pipes.

9.5 Contractor's submittals

9.5.1 General information on submittals

To ensure compliance with the requirements specified in the Contract, the contractor shall make a number of submittals as described in the following clauses to the Engineer for approval by the specified time. The contractor shall ensure that the submittals prepared are of good professional standard, comply with all the requirements specified in the contract and complete with all details and information to enable the Engineer to evaluate and approve the submission. It shall be clearly understood by the contractor that he shall not commence any work without the approval of the submittals by the Engineer.

Submittals by the contractor shall, include:

- Contractor's method of construction
- Microtunnelling equipment description and literature
- Jacking system and maximum jacking loads
- Pipe designs and shop drawings and calculation demonstrating the ability to sustain maximum jacking loads
- Intermediate jacking stations details
- Lubrication system
- Bentonite injection system details
- Ground water control details
- Entry and exit details
- Jacking and receiving shaft design details
- Thrust block details
- Muck removal and disposal
- Buried services details
- Detection equipment or any other trenchless technology system equipment etc.

All submittals shall be submitted by the Contractor in accordance with schedule mentioned.

9.5.2 Submittal on Contractor's method of construction- Microtunnelling including construction of shafts

The submittal shall contain a detailed explanation of various steps involved in the construction process. They shall include details of the equipment, specific manufacturer's instructions and guidelines pertaining to the project, a methodology statement outlining the operation of the equipment and, details of materials including pipe materials, rubber ring, and compressible packers and jointing of pipes.

The submittal shall also include construction details of other permanent and temporary structures such as jacking and receiving shafts, cast in-situ and precast Machineholes, or brick masonry Machineholes, thrust walls, and entry and exit of the shaft. The details of other equipment such as intermediate jacking stations, spoil removal system including slurry and feed pumps, control systems, slurry tanks and associated machinery, jacking frames, spacers, thrust ring etc., shall also be included in the submittal.

9.5.3 Submittal on geotechnical profile and geotechnical reports along the pipeline route

The Contractor shall establish the subsurface ground conditions and their range of variability along the pipeline before embarking on the works. He shall clearly identify the types of soil or rock that is likely to be encountered during boring or tunnelling along the entire pipeline alignment. If found necessary, he shall carryout simple probing techniques. (Geophysical soundings or Seismic refraction method and soil resistivity tests)

He shall prepare a comprehensive geotechnical profile along the pipeline route with detailed descriptions of the types of soil or rock to be expected during boring/ tunnelling.
The Contractor shall endeavour to carry out essential geotechnical investigations and tests (Field as well as laboratory) immediately after award of the work for enabling him to select appropriate equipment/ methods. The Contractor shall be solely responsible for geotechnical investigations and the inference drawn from such investigations as well as the adequacy of the equipment and method adopted by him. However, other progress of works like construction of shafts etc. may be continued simultaneously.

9.5.4 Submittal on jacking pipe design and carrier pipes

The contractor's attention is drawn to the requirement pertaining to the design, manufacture and handling of the jacking pipes. The jacking pipes shall be manufactured in accordance with JSWAS A2 or BS 5911 Part 120 or equivalent standard approved by the Engineer. At the same time the pipes shall meet the test requirements for NP4 pipes under IS 458.

The Contractor shall with the approval of the Engineer, engage a reputable pipe manufacturer to design and manufacture the jacking pipes. The submittal shall include the manufacturer's name, address, contact telephone and facsimile numbers and the manufacturer's quality assurance /control and testing plan for the jacking pipe.

The manufacturer's representative's name shall be also included in the submittal. A dimensioned drawing of the jacking pipe with design calculations from the manufacturer shall be also submitted to the Engineer for approval.

The submittal for jacking pipes shall include particulars of the pipe moulds, casting facility, QA/ QC for pipes, anti-corrosive protection to the pipe. The submittal shall be accompanied with a letter from the plant owner giving guarantee for delivery of the pipes in accordance with the schedule of work as planned by the contractors and as directed by the Engineer / Employer.

The Contractor shall furnish a Memorandum of Understanding between the RCC pipe manufacturer and the Contractor for supply of Jacking Pipes and also an undertaking from the pipe manufacturer that they possess a valid BIS license and have supplied at least 500m of jacking pipes of 1000mm and above which have been successfully installed by micro tunnelling anywhere in India.

In case MS jacking pipes are considered necessary as sleeve pipes as a requirement of contractor's methodology for micro tunnelling and pipe jacking, the same shall be at no extra cost to the Employer.

The MS sleeve pipes in such case shall be of appropriate size to accommodate carrier pipe of required ID and shall conform to IS 3589 and shall be coated with anticorrosive coating as per the IS code requirements. In such cases RCC carrier pipes conforming to IS 458 or HDPE pipes conforming to IS 14333 or IS 16098 Part 1 or 2 shall be installed inside the sleeve pipes.

9.5.5 Submittal on microtunnelling/ pipe jacking/ auger boring system

The bidder / Contractor shall furnish name of the micro tunnelling/ auger boring system, model, manufacturer's technical literature for the equipment and all other data along with their bid. Any amendments deemed necessary by the Contractors shall be submitted along with the geotechnical profile within 21 days of submission of geotechnical profile to the Engineer. The submittal shall include information to ensure that the micro tunneling/ auger boring equipment proposed for the project meet with the general requirements specified in these specifications and also the anticipated geological conditions. The submittal shall also include a certification from the manufacturer of the equipment about adequacy in the anticipated geotechnical conditions as also design calculations showing maximum anticipated jacking or pullback force and torque needed for tunnelling/ boring. The details shall also provide information of rock cutting tools or heads, spoil removal methods, guidance systems, jacking system and capacities, interjack systems, hole lubrication systems etc.

9.5.6 Submittal on site layout

Contractor's attention is drawn to various clauses in the document about the site constraints and space availability in all the sites. The contractor shall carefully examine the site and prepare site layout plans showing extent of work site, the arrangement of various ancillary equipment required for works, such as approaches for equipment, spoil removal equipment and slurry tanks, bentonite systems/ mud recycling system, generators, control cabin, tracking facilities, crane, storage of pipes etc for each drive and submit them progressively to Engineer for approval.

9.5.7 Submittal on existing pipe network details, ground and invert levels, location of shafts and new pipeline alignment

The contractor shall survey and verify the as-built invert levels of the upstream and downstream pipelines and Machineholes shown on the contract drawings for all the sites. The contractor shall confirm or insert the correct as-built levels in the contract drawings and submit them to the Engineer for necessary amendments and re issue of the contract drawings for construction. Under no circumstances the contractor shall commence works without verifying the as-built levels and obtaining the approval of the Engineer.

The Contractor will be required to set out and plan the actual placement of the alignment for the pipe laying well in advance of actual excavations. Trial holes/ probing and other preliminary surveys must be carried out and the resulting information carefully plotted.

For convenience of construction, if the Contractor prefers changes to the pipeline alignment or the location of Machineholes, he shall submit such changes to the Engineer for prior approval. The Engineer would evaluate and approve if the proposed changes are found to be economically and technically, and functionally acceptable. It shall be clearly understood by the Contractor that any construction risks and additional costs arising as a result of Contractor's changes made to the original pipeline design shall be entirely borne by the Contractor.

9.5.8 Submittal on jacking and receiving shaft design

The Contractor shall submit the design and construction details of the jacking and receiving shaft and their proposed locations along the pipeline route to the Engineer for approval. The Contractor's design shall ensure that the shaft dimensions are absolute minimum required and method of construction shall be such that the shafts are constructed without causing unacceptable obstruction to the existing traffic flow in the vicinity of the construction. The minimum size of the shaft shall, however, permit

construction of appropriate machinehole / valve chambers as per the requirements. The Contractors shall also submit design and construction details of decking, if required, for the shaft. The Contractor shall be deemed to have allowed for in his Bid for such decking work necessary to maintain the traffic flow.
The submittal shall also include details on shoring system, entry and exit arrangement, thrust wall layout and design details, general layout of guide rail and jacking table arrangement etc.

In case the shafts are to be constructed by method of well sinking, the contractor shall provide complete design details along with method of sinking, soil removal, dewatering, concrete steining, kentledge arrangement etc. for approval of the engineer.

In case of shafts in the form of RCC wells, branch connections to the Machineholes constructed inside the well shall be provided at no extra cost to the Employer.

9.5.9 Submittals for obtaining approval from authorities

The Contractor shall submit separate schedule for obtaining approval of various authorities and obtain specific permission or approval through the engineer.

9.5.10 Submittal on buried services and obstructions

The Contractors shall investigate and determine the actual location of the buried or over the ground services (Metallic and non-metallic) and physical obstructions, if any, along the pipeline route and at his chosen locations of the jacking and receiving shafts, and submit service location drawings to the authorities responsible for electricity, telecom, water, pipeline, gas etc and obtain their approval or permission to excavate in their vicinity. The contractor shall use a good quality Ground Penetration Radar (GPR) for this purpose and shall submit complete details of the equipment and procedures for field investigations and laboratory/ desk analysis of the data captured in field.

The Contractor shall not interfere with the operation of any existing or proposed service. He shall carefully plan the pipeline route and the locations of the shafts and Machineholes and shall identify the services that require diversion well ahead so as to give ample time to the authorities to divert the services or give approval to carry out the diversion by others. Where applicable, the Engineer would assist the contractors in getting the approval as expeditiously as possible from authorities.

If in the opinion of the Engineer any services that are within the machinehole proper or affecting the alignment and require permanent diversion, they shall be diverted at the expenses of the Corporation. Expenses for all other diversions and temporary protection of services shall be borne by the Contractor.

Any consequential delays or expenditure arising from Contractors' carelessness or lack of foresight on this matter shall be entirely borne by the Contractor.
The Contractor shall fully co-operate with the Engineer and the authorities and shall have no claim for delay due to such relocation of services.

The Contractor shall allow for sufficient time for getting the permissions from the authorities.

9.5.11 Submittal on monitoring of ground settlement and upheaval

The Contractor shall monitor ground movement daily at the start of jacking operation and end of the jacking operation on that day and submit in an approved format the settlement or upheaval caused by the micro tunnelling and pipe jacking works to the Engineer.

It shall be incumbent upon the contractor to measure ground movements along the route of pipeline laid for a width of at least 5m or 2 times the depth of the pipe being laid on either side of the center line using appropriate equipment such as seismographs, accelerometers during construction and measure them at least once in six months during the defect liability period and in case any settlement of ground or pipeline is observed, the contractor shall take remedial measures at his risk and cost.

The contractor shall also conduct a joint survey of structures in vicinity to monitor any cracks or signs of distress and take timely remedial measures at his risk and cost.

9.5.12 Submittal on Safety

The Contractor shall be solely responsible for safety of the workmen, Engineer's staff and third party. The contractor shall implement a comprehensive safety plan for his work people and Engineer's/ Employer's staff or Third party. He shall comply with all relevant acts governing safety on construction site. He shall submit to the Engineer the details of the arrangements he made with the fire brigade, local health authorities and the availability of medical staff, first aid equipment ambulance, sick bay etc. He shall give the names and contact telephone numbers (24 hours) of the occupational health and safety personnel. Beside he shall submit a list of safety equipment that he would provide to all the workers on site. The Contractor shall appoint a Safety Officer or Safety Engineer at all times who shall be the responsible person for all safety related matters pertaining to the contract. Name of such person shall be communicated along with the submittals on safety. The contractor shall comply with the guidelines issued by any competent authority regarding safety at work site especially safety of persons working inside any pipeline- new or functioning. This shall be consistent with the contractor's obligations under the GCC/ SCC.

9.5.13 Submittal on quality assurance/control plan

The Contractor shall implement a Quality Assurance Program approved by the Engineer for the manufacture of jacking pipe and for actual installation of the pipes trenchless method on site. The Quality Assurance Programme shall be maintained in accordance with the provision of the manual. No works shall commence until the Quality Assurance Manual has been approved by the Engineer.

The Contractor's Quality Assurance System shall incorporate but not be limited to the following:
(i) The Quality Assurance and Quality Control procedures covering all materials, design, manufacture, supply and installation carried out by the Contractor and any of his sub-contractors and pipe manufacturers.
(ii) Such tests necessary to demonstrate that materials comply with the requirements of this specification and the requirements of the relevant Standards and Codes.
(iii) Contemporary records to be maintained pertaining to progress of the work.
The QAP shall mention check points and hold points and must be scrupulously followed.
The Contractor must be ISO 9001-2015 certified organization and must submit the Quality Manual for implementation during execution of the works.

9.5.14 Submittal on Contractor's personnel

The Contractor shall note that the skill of MTBM operator and their assistants is crucial for successful execution of work. The contractor shall submit complete information for the operators proposed to be employed for the work. At least one MTBM operator must have an experience in operating MTBM in India.

The Contractor shall be required to deploy the key staff as committed during the bidding process. No change in the personnel shall be permitted subsequently without written approval of the Engineer. He shall submit the diagram showing the communication link within the site to Contractor's Head Quarters along with designation and telephone numbers of key staff for the Engineer's record. The Engineer reserves his right to reject any person who he thinks not suitable for the contract and the Contractor shall be obliged to replace such person immediately.

9.5.15 Submittal on remedial measures to be adopted by the Contractor

The Contractor shall take each and every precaution to ensure that the tunnelling or drilling equipment will successfully excavate along the chosen pipeline alignment before he commences the operation. Once the tunnelling/ drilling is commenced in a drive, the Contractor will be held fully and wholly responsible for the successful completion of the tunnel excavation and retrieval of the shield from the receiving shaft or for completion of pilot bore and hole enlargement upon back-reaming. In the event of inability to complete the drive, due to break down or any other reasons, the Contractor shall be fully responsible to recover the equipment safely from the ground and restore the incomplete work to the original condition at his risk and cost by a method approved by the Engineer and the concerned authorities within time stipulated by the Engineer or the concerned authority.

It shall be clearly understood by the Contractor that the occurrence of such an event is preventable as such an occurrence is generally due to Contractor’s negligence in the “preventive maintenance” of the equipment or driving of it to true level and gradient or his failure to determine accurately the expected ground conditions before commencement of the excavation.

The Contractor shall in his submittal clearly state the measures that he would implement to retrieve the shield without causing interruptions to railway, highway or road traffic etc., and without causing any damage to the property. The cost for such retrieval measures or any consequential expenditure or delays arising from thereof shall be entirely borne by the Contractor. Any failure to remedial measures shall be entirely at the risk and cost of the Contractor.

Any abandoned hole or tunnel must be grouted completely at the Contractor’s cost so as to prevent subsequent settlement.

9.5.16 Submission on work schedule

Notwithstanding the obligations of the contractor under the GCC, the contractor shall submit a detailed work schedule with suitable milestone events. The work schedule shall also take cognizance of the monsoon season, water levels and their fluctuations in the reservoir and their impact on ability to carry out the work etc.
A baseline schedule shall be submitted along with the bid which shall be frozen within 15 days of award of the work to successful bidder.

9.5.17 Effect of Approval and Acceptance of Proposals

Approval or acceptance by the Engineer of any proposal for executing the Works, including drawings, specifications or resources employed under the Contract shall not relieve the Contractor of his responsibility for any errors thereon and shall not be regarded as an assumption of risk or liability by the Corporation. The Contractor shall have no claim under the Contract on account of the failure or partial failure or inefficiency of any plan, method of work or equipment approved or accepted by the Engineer. Such approval or acceptance shall be considered to mean only that the Engineer had no objection to these proposals.

Notwithstanding any approval or acceptance by the Engineer, the Contractor shall remain fully responsible for completing the Works correct in every detail.

9.5.18 Schedule of submittals

Below is a general schedule of submittals pertaining to trenchless works by the contractors

Sr. No	Description	Schedule of submission
1	Contractor's method of construction.	Along with the bid.
2.	Geotechnical profile along pipeline route.	Within 30 days of date of commencement letter.
3.	Jacking pipe design	Along with the bid.
4.	Micro tunnelling system.	Original submission along with the bid and any changes necessitated by the geotech investigation shall be submitted within 15 days of submission of geotech profile.
5.	Site layout	Within 45 days of commencement dates.
6.	Proposed Intaek Location and shafts and new pipeline alignment.	Within 45 days of commencement dates.
7.	Jacking & Receiving shaft design.	Along with the bid. Any changes necessitated by the geotech investigation shall be submitted within 15 days of submission of geotech profile.
8.	Approval from authorities.	Within 90 days of commencement date
9.	Obstructions.	Within 45 days of commencement letter
10.	Monitoring of Ground settlement & up level.	Along with the bid.
11.	Safety.	Along with the bid.
12.	Quality assurance/Central plan.	Along with the bid.
13.	Contractors Personnel	Along with the bid.
14.	Remedial measures.	Along with the bid.
15	Work schedule	Along with the bid

9.6 Products

9.6.1 Standards and Codes

Except as otherwise stipulated in this Specification, all materials and workmanship shall comply in all respects with requirements of such standard and specifications, codes and other standards issued by the Bureau of Indian Standards (BIS) and current at the date of bid as may be applicable to any part of the Works of this Contract. In the event there being no relevant Indian Standard Specification, other relevant standard, specification, current at the date of bidding such as the British Standards Institution (BS), American Society for Testing Materials (ASTM), German Standards (DIN), Japanese Standard for Water and Sewerage (JSWAS), and/ or of the or any other equivalent standard approved by the Engineer shall apply. If after the date of invitation to Bid there is an amendment to a standard specification relevant to the Contract, the Engineer will direct whether the amendment is to apply.

In the event of there being any conflict between this Specification, the Drawings and any Standard Specification forming part of this Contract, this Specification shall take precedence over the drawing, codes and other standards in that order of precedence. In any case, the Engineer's decision shall be final and binding on the Contractor.

9.6.2 Selection of Equipment

The contractors shall be responsible for the selection of a suitable micro tunnel boring machine capable of excavating the materials including soft marine clay with high water table, rocks and mixed ground that may be encountered along the route of the pipeline to be laid under the contract.

The Contractor shall be solely responsible for ensuring that geological and geotechnical information he obtains or possesses for the sites is adequate to accurately determine the types of soil that may be encountered during execution of the project. The contractor is deemed to have carried out sufficient geological and geotechnical investigation of the sites and testing of the soil as necessary at his own cost before the selection of the micro tunnelling system.

Contractor shall be responsible for selecting suitable equipment for trenchless installation of the sewers capable of excavating all soil types which may be countered during the execution of the project.

The contractor shall also ensure that the system he selects for the project shall successfully excavate in the wide-ranging ground conditions from clayey and sandy strata to mixed ground/ hard rock that may be encountered along the route.

Contractors shall pay particular attention, when selecting the tunnelling/ boring equipment for the project, to ground water level fluctuation and the subsurface soil strata from marine clays, sands, gravels, soft soils that may be present at the sites. The equipment selected for the project shall have appropriate cutter head equipped with suitable cutter bits to excavate all types of soil formations below the water table.

The tunnelling/ boring equipment shall be capable of balancing the ground water pressure supporting the excavated tunnel face at all times. The equipment shall be articulated to enable remotely controlled steering, in both the horizontal and vertical directions. It shall be capable of preventing rotation and rolling movement of shield's body during the drive. The tunnelling/ boring equipment shall, have the following features.

(a) Equipped with suitable steering and guidance system that ensures easy steering control (With arrangement for anti-roll, or pitching/ dipping)
(b) Equipped with a suitable lubricating system arrangement
(c) Ability to provide for an Intermediate Jacking Station, as needed
(d) Instrumentation to measure deviation from the designed level and grade, rolling and pitching of the equipment, cutter torque and its percentage to the maximum torque, rpm, jacking speed, tunnel face pressure etc. preferably with a computerized data logging and printing facility.
(e) Spoil removal system (Slurry/ Auger system) capable of removal of excavated stuff by balancing the face pressure.
(f) The machine hall be manufactured by a reputed manufacturer having supplied at least one such machines during last five years in India and the supplied machines must have successfully carried out underground pipe installation work for a length of at least 500m.

The equipment proposed for the project shall meet the above-mentioned criteria failing which it will not be permitted to be used in the project.

9.6.3 Jacking Pipes (RCC/ MS)

The pipes must be manufactured in a reputed pipe manufacturing facility using vertical vibration casting method having valid BIS license for manufacturing of RCC pipes from450mm to 1400mm (NP3/ NP4 Class) under IS 458.

Pipes manufactured by the contractor's themselves in a temporary manufacturing facility shall not be acceptable.
The pipes for jacking operation shall be precast reinforced concrete pipes manufactured by vertical vibration casting process only.

Design, manufacture and factory testing of the pipes and specials shall be to BS 5911 Part 120 or JSWAS A-2-1973 or other acceptable standard and shall meet the test requirement specified in I.S 458 (NP 4 Class) or its equivalent standard as amended up to-date. The grade of concrete shall not be less than M45 design mix. The clear cover of concrete over steel reinforcement on the wet side shall not be less than 25mm.

The jacking pipes shall be provided with Stainless Steel Collars fixed to the female end of the jacking pipe.
Each pipe shall be provided with a precision cut compressible packer to be attached to pipe end with approved adhesive. The Contractor shall also provide details of the compressible packer including its dimensions, Modulus of elasticity etc.

The outside and inside diameters of the pipe shall be such that they match the dimensions of the tunnelling equipment or vice versa. The standard length of the pipe shall be 2.5m (Between 2.43m to 3.05m). However, the length of the pipe shall be shortened if desired by the contractor to suit the site conditions subject to the Engineer's approval.

The concrete used for jacking pipes shall be from a RMC plant. If the concrete for manufacturing pipes is produced at the plant itself, it shall be manufactured in an approved automatic batching plant. Complete details of the Batch of ready mix concrete like its Grade, WC ratio, maximum aggregate size, time of leaving the RMC plant, time of pouring into the moulds, additives and suppliers certificate shall be maintained for each batch. Three cube samples shall be taken from each RMC batch and tested for 28 days strength in a laboratory approved by the Engineer. If the test cubes fail the requirement, the finished pipe shall be liable for outright rejection after NDT (Schmidt Hammer Test or any other as directed by the Engineer).

The Engineer's representative shall have full authority to inspect any material or finished product and reject the same if not found conforming to the standards. The Contractors shall make his representative available to the Engineer's representative during such inspections and testing failing which the Engineers representative shall be at liberty to take ex-parte decision, which shall become binding upon the Contractor.

The pre-cast reinforced concrete pipes shall be sufficiently reinforced with steel to withstand all stresses induced by handling, jacking, earth and water pressures and all working loads at the depths at which they are to be used without cracking, spalling or distortion. The pipes shall be of at least strength Class NP4. A load factor (for the maximum jacking force) of not less than 2.0 shall be used in the calculations to determine the strength of the pipes required. The strength of the pipes shall be tested by the three-edge bearing test. When subjected to the design load in such a test, the load required to produce the crack width of 0.25mm on the pipe shall be in accordance with IS Code 458. All such tests shall be carried out at the expense of the Contractor. The frequency of the Three Edge Bearing test shall be at least once in 3 months or every 100 pipes or part thereof for each diameter.
When designing the jacking pipes, the contractor shall take into consideration jacking load including eccentric loading, pipe stiffness, corrosion resistance, flexibility, durability, joint efficiency etc.

The Contractor shall take precautions to minimize the resultant pipe stresses in a jacking pipe and to achieve a trouble free jacking operation. The eccentric loading shall account for maximum steer ability.

The Contractor shall submit full details of his proposals for the pipes, giving detailed drawings showing sizes, reinforcement and type of joints, calculations, together with the name of the proposed manufacturer, the place of manufacture and the manufacturing process to the Engineer for approval along with a consent letter from manufacturer of the pipes from such manufacture as well as the RMC supplier.

A detailed record (signed jointly by the Contractor's and Engineer's Representative) of concrete batch, its 7 day and 28 day strength, weight of reinforcement cage, weight and dimensions of the collar etc. shall be maintained for every pipe manufactured for use in the works.

Every pipe tested for the three Edge Bearing Strength shall also be tested for ultimate (crushing) test in presence of the representative of the Employer or PMC and/ or Third Party Inspection Agency. The pipe to be tested for three edge bearing test shall be randomly selected by the Engineer or any designated agency. At least one pipe in 200 pipes for each diameter must be tested for three edge bearing test outside the manufacturer's factory in a test facility as directed by the Employer. The test set up and the gauges shall be properly calibrated with a certificate from an agency authorized to do the calibration of equipment. The pipes shall meet the requirements of the Standards for Jacking pipes like JSWAS/ BS or any other acceptable standard but the requirements of strength and other tests like hydraulic and permeability shall be in accordance with IS 458.

All workmanship and materials used in the manufacture shall be subject to the approval of the Engineer who shall be authorized to inspect materials at source and the manufacturing processes in the factory at any time.

Proper curing arrangement in the form of water spray curing, steam curing or chemical curing as approved by the Engineer shall be provided.

(a) Pipe shall be straight and uniform with square ends. The joints shall be well formed to allow efficient transfer of jacking load from pipe to pipe
(b) Pipe joint shall be fitted with compressible packer for better distribution of jacking load.

(c) The jacking frame, jacks and steering head shall be properly aligned along the designed alignment and grade and the whole assembly shall be square and at right angles to the thrust wall
Steering corrections shall be made gradually to minimize abrupt misalignment angles between the pipes

The pipes should be provided with well-formed arrangement for groove for rubber gasket.
The pipes shall be internally lined with "T" rib type HDPE sheet lining as corrosion barrier (2 to 3mm thick) installed while casting of the concrete pipe.

The pipes shall be sufficiently cured (Minimum 28 days if wet cured with water spray or as approved by the Engineer is cured with steam or by application of chemicals) before they are dispatched to the works sites and used in the jacking process. They shall be handled with extreme care to prevent the edges of the pipes from chipping. The pipes shall be stacked in shade or adequately protected from severe sunrays. The Engineer may reject any pipes he considers not suitable for the Works and these rejected pipes shall be removed from the site immediately. After factory testing and before dispatch, every pipe and special shall be marked in accordance with the Standard used. In addition, each pipe shall be marked with a number corresponding with the order of manufacture and date of manufacture and Grade of Concrete. Test certificates from the manufacturers or other relevant authority shall be submitted to the Engineer.

The pipe manufacturing and testing process shall also be subject to Third Party Inspection. Pipes shall not leave the manufacturer's facility unless they are released by the TP agency/ PMC/ the Employer.
The sites may have limited or restricted storage space for stacking of jacking pipes. The Contractor shall therefore schedule the supply of pipes to the sites in such a way that only absolute minimum numbers of pipes are brought to the site at a time.

In case of MS jacking pipes, the pipes shall be manufactured and tested in compliance with IS 3589 and shall be provided with liquid epoxy coating/ lining system as per ANNEX B of IS 3589.
Carrier pipes shall comply with the relevant IS Standards.

9.6.4 Pipe Joints (RCC and MS)

The jointing arrangement for the jacking pipes is crucial in terms water-tightness, flexibility and smooth transmission of jacking force. Spigot ended jacking pipe with recess to receive rubber rings and stainless steel/ Mild Steel couplings (collars) or other acceptable joints shall be used in pipe-jacking application. The spigot and socket joints shall be flush from outside as well. The contractor shall submit joint details to the Engineer for approval.

The joint rubber rings supplied and installed shall be of the Cornelius rubber ring type or similar approved and shall be capable of accommodating 2 degree deflection at each joint. Joint rings shall meet with the latest edition of I.S 5328 and B.S 2494 part 2 or be of approved quality by the Engineer.
The properties of the joint ring shall be between those specified in BS 2494 for grade D and grade B.
The testing of rubber ring shall conform to IS. 3400 and also IS. 5382.

The Contractor shall indicate the grade of rubber rings he intends to use and submit samples for approval prior to incorporation in the Works. The grade, type or source of supply of rubber rings shall not be changed without the written approval of the Engineer.
MS pipes shall be with welded joints as per IS 5822

9.6.5 Pipe Couplings (Collars for RCC jacking pipes)

The pipes shall be provided with **Stainless Steel (SS 304 Grade) Collars.** The arrangement shall be of such dimension and thickness so that when inserted into the pipe, it fits exactly into the recesses in the pipe. The joint so formed shall be watertight. The joint details shall be approved by the Engineer. The thickness of collar shall not be less than 8mm.

9.6.6 Compressible packers

Appropriate compressible packers shall be used at the joints for distributing the jacking force evenly through the wall of the jacking pipes. Uneven transfer of jacking force from a pipe to another shall result in concentrated and excessive stresses in the pipe which can cause the pipe to crack. Contractor shall submit details of the compressible packers for Engineers approval.

9.7 Identification of pipes, rubber rings etc.,

Every pipe made shall be clearly and indelibly marked upon it unique identification number, class, batch of concrete, diameter and date of manufacture. (Suggested format: FACT_NAME /DDMMYYYY/Mxx/BATCH_NO/ NNN) Every finished pipe shall be tested for dimensional conformity and non-destructive testing with Schmidt Hammer or any other method as approved by the Engineer. Full records are to be maintained of each pipe test and for each individual pipe the date manufactured, cleared after testing and supplied on site.

The Contractor shall make arrangements for visits of the Engineer's representatives for inspection and 3 EB testing as and when deemed necessary by the Engineer. All expenses in connection with such visits shall be borne by the Contractors. After the satisfactory completion of testing and approval of the pipes by the Engineer the pipes shall be stored at factory premises during the period awaiting delivery.

No pipe shall leave the manufacturer's yard for the site unless it is tested and cleared by the Engineer's representative and the Third Party Inspection agency appointed by the Engineer/ PMC.

9.8 Tests on Jacking Pipes

Factory Tests

One pipe out of every 100 pipes or part thereof manufactured for each diameter shall be tested for Three Edge Bearing Test in the factory or a laboratory or institution approved by the Engineer at the Contractor's expense. Besides this at least one pipe in every 200 pipes shall be tested outside the factory in a facility as directed by the Engineer. The pipe for testing at a test facility outside the manufacturer's factory shall be selected at random from the pipes delivered at site. All expenses in connection with transportation to and fro, loading/ unloading, ant taxes/ fees etc shall be borne by the contractor.

Every RCC jacking pipe shall be subjected to following dimensional conformity tests and the tolerance shall be within limits as indicated below -

1. **Length**

Pipe Dia in mm	Tolerance for all types of pipes in mm
Above 1200	+25

2. Perpendicularity of faces

Pipe Dia in mm	RC Jacking pipe
Above 1200	8

3. Deviation from straight

Pipe Dia in mm	Tolerance for all types of pipes in mm
Above 1000	±10

4. Deviation from pipe d

Pipe Dia in mm	Tolerance for all types of pipes in mm
Above 1000	+0, -16

9.9 Execution

9.9.1 Information for the execution of works

The works under the scope of trenchless technology shall have to be carried out using approved trenchless technique.

The Contractor shall be responsible for inspecting the sites and familiarizing himself with the conditions under which the work will be performed and with all necessary details including geotechnical conditions and buried services as well as the physical conditions, tidal impacts etc. as to the orderly and successful execution of the work. The omission of any details shall not relieve the Contractor of full responsibility for the satisfactory installation of the work in its entirety. No monetary or other claims made by the Contractor on the grounds of want of knowledge will be entertained by the Engineer.

Plans and details of the equipment, materials and the method of construction to perform and complete the work shall be submitted by the Contractor for approval of the Engineer before commencing these operations. Approval by the Engineer shall not relieve the Contractor of his sole responsibility for the efficiency, reliability, and soundness of the method employed in completing the work in a satisfactory manner.

The Contractor is advised that it shall be his sole responsibility to ascertain for himself the extent of work that is required to be done in site and to generally obtain his own information on all matters affecting the execution of the whole of the works involved in this contract to the entire satisfaction of the Engineer. No claim of extras in consequence of any alleged ignorance in any aspect will be entertained by the Engineer. It must be clearly and definitely understood that the contractor shall be held solely responsible for making all necessary arrangements and coordinating with all relevant Authorities, Specialists, Sub Contractors, etc., to ensure satisfactory and timely completion of this contract.

9.9.2 Execution of works-General

The Contractor shall be fully responsible for the design and construction of the jacking/ launching and receiving pits, thrust wall, installation of jacking equipment, installation of any other equipment, sheeting/ shoring, bracing, etc., and for the efficient execution of the work.
The Contractor shall be required to monitor closely the progress of the trenchless operations. Daily manual logs or site records of thrusting pressures, torque, bentonite injection rate and the line and level measurements shall be properly maintained in addition to any computerized data logging and shall be available to the Engineer's representative at all times. Such records shall be duly signed by the Contractor's site in-charge. If the Contractor fails to maintain and produce such details before the Engineer's representative on site, the Engineer's representative may order suitable steps including suspension of the work without prejudice to any other rights of the Engineer. The Contractor shall be solely responsible for such actions ordered by the Engineer's representative.
It is the responsibility of the Contractor to ensure that the completed pipelines are watertight. If leakage occurs before completion or during the maintenance period, the Contractor shall carry out any remedial work that may be necessary to make the Works watertight all at his own expense.

9.9.3 Location and verification of buried services

The Contractor will be held solely responsible for making his own investigations of any buried services in the vicinity of the Works and to protect them from getting damaged due to his work. Contractor shall be deemed to have allowed for any extra costs in his rates for detecting all obstructions and buried services including appropriate measures to protect the services and temporarily divert the same in consultation with the concerned agency with its prior approval regardless of whether they are indicated on the drawings or not. It shall be the Contractor's responsibility to obtain any permission from such agencies. The Engineer/ Employer may issue necessary recommendation letters to the concerned utility agencies if required.

The contractor shall engage at his own cost a competent service detecting professional or agency who shall have state-of -the -art detecting equipment to locate and verify all the buried services such as pipeline, water, telecom, electricity, gas and all other services, and abandoned services and structures well ahead of commencing the works.

The detector shall be able to receive narrow signal responses from metallic or non-metallic buried services in order to pinpoint the position and direction of the services. It shall also be able to pick up the position and direction of different services in congested area and detect the buried services regardless of almost any environmental interference.

Combination of Ground Probing Radar (GPR) and Electromagnetic Location (EML) testing shall be used for locating the underground utilities and buried objects. The lines tested using GPR and anomalies located using EML shall be topographically surveyed using a Total Station / Theodolite at the same time as the geophysical testing is carried out.

The information so collected shall be submitted to the Engineer after getting it confirmed from the respective agency. It shall be clearly understood by the Contractor that no work shall be carried out without locating all the buried services and he will be held solely responsible for any consequential expenses and delays if he ignores this specific requirement or fails to locate any services along the route.

The Contractor shall take every precaution that in the opinion of the Engineer and as advised by the owner of the utility is necessary for the protection from injury of all existing and proposed water,

drain, pipeline and other pipes, electric and telephone conduits, and other existing works, roads and services wherever encountered or which are adjacent to the works, and to maintain the same until in the opinion of the Engineer the general progress of the work renders further protection unnecessary. All damage occasioned by the Contractor to these works and services shall be repaired at once at the Contractor's risk and cost, as directed by and to the satisfaction of the Engineer.

9.9.4 Site investigation

The Contractor's site investigation for trenchless works in general shall be critical and the most important engineering work to be carried out before commencement of work on site. The contractor shall clearly understand the importance of establishing the subsurface ground conditions and their range of variability along the pipeline route well before embarking on the actual works. There should not be any room for unforeseen ground conditions and it is absolutely necessary for the Contractor to know what is to be encountered during the tunneling operation. The contractor shall be deemed to have accurately established the types of soil and rock strata along the tunnel bore and their range to enable him to select the equipment / machines and to set-up and operate correctly.

9.9.5 Subsurface investigation

The subsurface investigation shall include study of all existing geological and geotechnical information for the area including the information pertaining to the project and the location maps of all the services in the area from the utility companies/authorities for initial planning. Data on abandoned and existing obstruction, foundation, piles and the structures in the vicinity of the alignment shall be also collected. Field survey using utility services locator and trial trenches may also be carried out to verify the location of the services and obstructions.

Mapping out of the subsurface soils/rock profile along the pipeline alignment and locating underground utilities and buried objects by geophysical testing. Investigations may include documentary survey; bore logs, geophysical investigations, in situ & laboratory soil / rock tests. Various geophysical investigations include but not limited to Ground Probe Radar (reflection of electromagnetic waves), Radio Magnetotellurgy (measurement of resistivity in electromagnetic field of a radio transmitter), Electrical Method (measurement of apparent resistivity by injection of direct current and measurement of potential difference), Seismic Refraction (refraction of seismic waves on layers at speed increasing with depth), Seismic Reflection (reflection of seismic waves on contrasting interfaces), Microgravimetry. (local variation in gravitational field to detect cavities)

The Contractor is deemed to have allowed for any extra costs in his rates and to be aware of similar state of the art ground probing/mapping technology currently available on the market and to have made provision for its use in the project as part of his subsurface investigation works.

The contractor shall be deemed to have in possession of all the information and data required to accurately evaluate the subsurface conditions before commencement of any works.

9.9.6 Geological and geotechnical evaluation

The Contractor is deemed to have obtained, studied and evaluated all the geological and geotechnical data for the sites including any data if available with the corporation for the sites and made his own judgment and conclusion on the types of soils and rock to be excavated along the pipeline route. The Contractor must supplement this information possessed by him with appropriate geotechnical investigation prior to selection of appropriate micro tunnelling/ drilling machinery upon award of the work.

The applicant shall inform him thoroughly and make his own deductions as to the nature of the materials to be excavated; the difficulties of making and maintaining the required excavations and of doing other work affected by the geology of the Site and shall accept full responsibility thereof.
The Contractor shall carry out exploratory boreholes as deemed necessary by him and conduct laboratory testing as necessary for a micro tunnelling project. This information shall be supplemented with tests such as soil resistivity tests and seismic refraction test to provide complete information about the stratigraphy in connection with the proposed works.

It shall be obligatory for the contractor to prepare a geotechnical profile along the alignment showing the proposed sewer line superimposed thereon to indicate strata anticipated. The contractor shall also detect and plot the buried services on the topographic survey map indicating their position in plan as well as approximate depth below GL.

However, this does not absolve the contractor from his responsibilities for successful completion of the work.

9.9.7 Bore logs and ground probing

Sufficient numbers of boreholes shall be taken by the Contractor. The Contractor should submit Geotechnical profile along the route of the pipeline and buried services data for the entire alignment per the schedule for submittals.

Continuous sampling shall be resorted to over at least 2xDia above the crown of the pipe and 2x Dia below invert of the pipe to be laid.

The Contractor shall collect soil/ rock samples at the level of the proposed pipeline in presence of the Engineer's represent and get the same tested for sieve analysis, cohesion, angle of internal friction, ground water level, Unconfined Compressive Strength (UCS), abrasivity etc. at any laboratory approved by the Engineer. Samples taken in absence of the Engineer's representative and tested in a laboratory not approved by the Engineer shall not be valid for determination of the any parameters.

9.9.8 Groundwater investigation

Ground water condition is one of the critical data required when selecting the trenchless technology system. Ground water affects the safety of the excavation face, start and exits of the tunnelling/ drilling equipment from the shafts. Uncontrolled extraction of water from the surrounding during excavation can affect the adjacent structures. Piezo-metric pressure, water leakage, ground water level and etc., shall be carefully checked before and during microtunnelling/ drilling/ boring works.

9.9.9 Ground stabilization/ improvement

It shall be the responsibility of the Contractor to maintain stable soil conditions at the jacking face to prevent loss of ground above the jacking operation and movement of the surrounding earth or to prevent diving of the machine and sinking of pipes. The methods of maintaining face stability and preventing ground movement and subsidence shall be by means of fluid slurry or earth pressure applied to the tunnel face. Alternatively, unstable ground ahead of the jacking face may be stabilized by the injection of suitable chemicals. Methods which require dewatering of the ground will not be accepted, nor will methods which may lead to significant ground loss.

Movement or settlement of structures, utilities and pavement shall be monitored by the Contractor during the trenchless operation and reported to the Engineer and concerned authorities.

The Contractor shall make provision to install peizometers, settlement plate etc., in his rates for pipe installation if movement or settlement occurs, which in the opinion of the Engineers may cause damage, the Contractor shall take immediate action to prevent further movement, settlement or damage. The Contractor shall repair at his risk and cost any damage and restore structures, and pavements to the satisfaction of the Engineer. The contractor shall pay expenses if the owner or concerned agency or any Third Party elects to carry out such repairs by themselves.

9.9.10 Setting out

The Contractor shall be deemed to have thoroughly examined the sites, the location of the buried services, availability of space for footprint, access to sites & etc., and adjusted the pipeline alignment as deemed necessary and obtained approval of the final pipeline alignment from the Engineer before commencement of the setting out. He shall set out and mark on the ground the proposed pipeline route and the locations of the jacking and receiving shaft and the area they occupy for the Engineer's inspection and approval.

The Contractor shall be solely responsible for the accuracy of the setting out and any expenses or delays arising from errors made in the setting out shall be borne by the Contractor. Any consequential work or abortive work carried out by the Contractor to rectify the errors shall be entirely borne by the Contractor.

9.9.11 Site layout

The working space at the sites is often restricted and hence the site layout has to be planned carefully in advance to set-up the equipment and accessories.

9.9.12 Construction of Jacking and Receiving Shaft

The excavations for Jacking or Receiving shafts may be used for construction of Machineholes inside them provided proper branch connections as directed by the Engineer are cut in the wells sunk for shaft. The Contractor shall submit to the Engineer for approval dimensioned drawings and calculations of the timbering or trench sheeting details for the shafts. Each shaft shall have a separate ladder bay for access which shall be isolated from the part of the shaft used for hoisting materials. The shaft trenching shall be watertight and shall prevent any pressurized slurry from the tunnel face reaching the shaft.

Soil improvement methods that can be used include grouting, ground freezing, and dewatering. If the ground consists of unstable soil, the same may be stabilized by vibro / dynamic compaction, by compressed air for sandy soils and by ground freezing, preloading, lime treatment for clayey soils. In certain instances, ground treatment or groundwater management methods may be required to enable the construction of the shaft to proceed. These include well pointing and deep wells, Compressed air, Suspension grouts, Chemical stabilization, Ground freezing.

There are various shaft construction method alternatives, Liner plates, 2-flange steel liner, horizontal metal sheeting, sloping or battered excavation, trench boxes, slide railing system, soldier piles with timber lagging, soldier piles with steel lagging, steel / concrete / RCC sheet piles, CMP shafts, concrete sinking shafts, precast concrete segments, concrete slurry walls, Pre-cast or cast in- situ caissons, Rock anchorage rods and tensioned rock bolts, metal straps, un-tensioned steel dowels, Wire mesh with guniting and ground freezing. No extra payment shall be claimed by the contractors for carrying out soil improvement / stabilization, or shaft shoring techniques as mentioned.
The Contractor shall submit the design and construction details of all Temporary Shafts and their proposed locations along the tunnel alignment to the Engineer for acceptance. The submission shall also include details on shoring system, entry and exit arrangement, thrust wall layout and design

details, general layout of guide rail and jacking table arrangement etc. Temporary Shaft drawings are to include but not limited to:

1. Launch/jacking and reception shaft configurations.
2. Design and construction of launch/jacking and reception shaft.
3. Details for excavation and backfilling procedures, ground support systems, and ground stabilization if required.
4. Special requirements for jacking and receiving shaft penetrations, thrust blocks, backstops or other reactions required for Microtunnelling/ pipe jacking/ auger boring, casing pipe jacking or any other jacking.
5. Full calculations supporting maximum jacking capacity that jacking shafts will withstand
6. Dewatering and ground water control plans for all temporary and permanent shafts.

The shaft shall be kept dry at all times and shall have a drainage sump to pump out the ingress water. The Contractor is deemed to be fully aware of the serious consequences to the tunneling equipment and other accessories if the shaft is flooded. He shall take every precaution to avoid flooding in the shaft the shaft shall be well protected against surface runoff getting into the shaft. The contractor shall be solely responsible for any consequential delays and expenditure arising as a result flooding the shaft.

The shaft floor shall be designed to withstand the tunnel machine and other accessories.
The Contractor shall be solely responsible for providing and subsequent removal of shoring to the shafts or pits and ensuring stability of the sides of such excavations and safety of adjoining structures.
The sizes of the shafts shall be kept as small as possible considering site constraints. Equipment manufacturer's data on required shaft sizes shall be furnished to the Engineer along with the bid. The sizes of pits shall take due cognizance of available space needed for jacking frame, shoring or feed pumps or other ancillary equipment, thrust wall and entrance ring.

Considering the ground and physical conditions at site, the shafts may be constructed using well sinking method as preferred method. The contractor shall be solely responsible for design, erection and maintenance of the caisson shafts constructed by him using well sinking.

9.9.13 Construction of Thrust Wall

Thrust wall shall be designed and constructed by the contractor to the approved details. The thrust wall shall be reinforced or unreinforced concrete constructed against the wall of the jacking shaft. The Contractor shall ensure that the thrust wall is constructed as an independent structure and it shall not interfere with the jacking shaft or the floor when jacking force is applied on to it. Contractor shall indicate in his submittals the construction details of the thrust wall showing details on how the wall be made independent of the jacking shaft structure.

The Contractor shall ensure that the thrust wall and the soil behind are in complete contact and there is no gap between them. The contractor shall further ensure that the thrust wall shall effectively transfer the jacking force on to the soil behind and that the ground behind is capable of withstanding the jacking force.

In the event that there is gap between the thrust wall and the soil behind, the Contractor shall arrange the gap to be filled with approved cement grout before loading the thrust wall.

9.9.14 Installation of Guide Rails/ Jacking frame

The Contractor shall design and fabricate the guide rail / Jacking frame in accordance with the equipment manufacturer's details and install it firmly onto the floor of the jacking shaft. He shall ensure that the guide rail / jacking frame is installed to the correct grade, levels and alignment. It shall be also square to the pipeline alignment at all times and not disturbed due to forces arising from the jacking operation. He shall arrange with the Engineer's representative to check the level, alignment etc., of the guide rail and obtain the Engineer's endorsement before commencing guide the pipe jacking work.

9.9.15 Entrance and Exit Arrangement

One of the most critical operations is the launching and retrieval (entry and exit) of the micro tunnelling/ boring machine. Often this process takes place well below the water table. In those cases, it is critical that the contractor implement adequate engineering measures including improvement of unstable soil by grouting or other means to prevent soil and water inflows into the shaft.

It is common practice to install a rubber seal at the entry and exit. The seal is to prevent the flow of ground water or lubricant (used for reducing the frictional resistance) through the shield/pipe entry opening on the shaft wall.

An exit ring must be provided without exception if the strata at the level of exit happens to be loose. The Contractor shall plan this work well in advance and fabricate the fittings and rubber seal as per approved method.

Machine exit in to the reception shaft will not be permitted unless the reception shaft is provided with proper exit ring.

9.9.16 Soil Improvement at the Tunnel Entry and Exit

In addition to the seal, it may be necessary to stabilize the soil behind the entrance wall. This is to prevent any free flow of unstable soils into the pit when opening is made for the shield to enter into the ground. Chemical grouting, cement grouting, jet grouting, piles, ground freezing or temporary shoring are some methods commonly used by the contractors to prevent the soil flow into the shaft.

9.9.17 Cement Grouting

The Contractor shall be fully responsible for preventing the occurrence of voids outside the pipe and if they occur he shall fill them with cement grout. Immediately following the jacking operation the Contractor shall pressure grout the jacked section to fill all voids existing outside of the pipe. Grouting shall be from the interior of the pipe through grouting holes as specified. The grout mix shall be at least of CM 1:3.

Systems of standard pipe, fittings, hose, and special grouting outlets embedded in the pipe walls shall be provided by the Contractor. Care shall be taken to ensure that all parts of the system are maintained free from dirt. Grout composed of cement, sand and other approved compound and water shall be forced under pressure into the grouting connections at the invert and shall proceed until grout begins to flow from upper connections. Connections shall then be made to these holes and the operation continued to completion.

Apparatus for mixing and placing grout shall be of a type approved by the Engineer and shall be capable of mixing effectively and stirring the grout and then forcing it into the grout connections in a continuous uninterrupted flow.

After grouting is completed, pressure shall be maintained by means of stop cocks, or other suitable devices until the grout has set sufficiently. After the grout is set, grout holes shall be completely filled with dense concrete and finished neatly without evidence of voids or projections.

9.9.18 Jacking System

The hydraulic jacking system shall be installed against a purpose-built thrust wall in the jacking shaft. The jacking force required for jacking pipes and the tunnelling/ boring machine shall be provided by high pressure jacks driven by hydraulic power packs with appropriate factor of safety. The ram diameter and stroke of the jacks may vary according to individual contractor's technique and to suite site conditions.

The jacks shall be mounted on specially made frames so that the jacks are square to the pipe alignment. The jacking frame shall be firmly supported to the floor so that it does not move during jacking operation. A push ring shall be used to transmit the jacking force evenly to the pipe.

There are jacking systems with multiple strokes or long stroke mounted on a specially made jacking frame available to push a full-length pipe in a single setting. The system does not require the use of spacers and hence a substantial increase in productivity can be achieved by using multiple stroke jacking system.

9.9.19 Jacking force

The Contractor shall calculate the anticipated jacking load for each micro tunnel/ pipe jacking/ auger boring drive well ahead of designing the jacking pipes. Accurate estimation of the jacking load is necessary to determine the pipe wall thickness, the need for intermediate jacking stations and lubrication requirements, types of jacking system and thrust block design. The overall jacking force depends on the type of surrounding soil, depth of cover, pipe materials, diameter and the overall length of the pipeline. The total jacking force essentially consists of two components, "Frictional force around the pipeline" and the balancing force at the tunnel face called "Face Pressure". The Contractor shall use appropriate geo-mechanics formulae and guidelines for computing the jacking force. The contractor shall calculate the anticipated jacking force for each drive and submit his calculation to the Engineer for approval.

The Contractor shall be solely responsible to ensure that the pipes are not subjected to excessive jacking force or torsional force so as to crush them. If such thing occurs the contractor shall have to remedy the situation at his risk and cost.

9.9.20 Pipe Lubrication System

The boring machines are commonly designed to overcut about 10mm (in some cases up to 20mm) around the external diameter of the pipeline. The pipeline can, in theory, be jacked freely through a fluid medium by injecting a clay based (bentonite) or polymer based lubricant into this annulus. In practice, however, fluid losses may occur into the surrounding ground. The contractor shall carefully monitor the jacking force and use appropriate lubrication system, to bring down the jacking force within the allowable jacking force for the pipe.

9.9.21 Protocol of each Drive

After completion of particular drive / work or as directed by the Engineer, Contractor shall submit within five days a proper & authentic `PROTOCOL' (both soft & hard copy) of Micro tunnelling machinery for that particular drive / work, to the Engineer. Protocol must reflect date time, length,

various pressures of main jacks, steering jack's extensions, and cutter head torque & face pressure, slurry & feeder pumps-flow rate, pump pressures, deviations in vertical & horizontal alignment, roll, pitch etc. No extra payment shall be admissible for this requirement.

9.9.22 Special Traffic Precautions

The Contractor's attention is specially drawn to the requirements by the traffic police and road authorities and Specifications regarding Traffic Control, Access and the Reinstatement of road surfaces etc. It shall be the responsibility of the contractor to obtain permissions from traffic police and other authorities well in advance of the commencement of the works.

The Contractor's progress/ programme and road opening schedule must be arranged in details for discussion with the Engineer and the Traffic Police. The laying of pipelines must be broken into appropriate sections, and, where necessary, special traffic diversions arranged.

Whenever carriageways are affected, the Contractor must arrange to contain the works within the narrowest possible area. Excavated material must be removed as the work proceeds or contained within the areas designated by the Engineer/ Traffic Police.

The Contractor shall carry out the work in such a manner as to cause minimum interference with the public use of highways, footpaths, and other thoroughfares.

All workmen working on roads are required to wear approved retro-reflective vests at all times.
The Contractor shall include in his rates for compliance with all the conditions stipulated above.

9.9.23 Road Opening

Where Machineholes have to be constructed on existing metalled or concreted road, the Contractor is required to submit a detailed road opening schedule to the Engineer for approval.

The Contractor shall contain the works within the narrowest possible area when laying pipelines along metalled or concreted road.

Traffic flow must be maintained at all times along the roads affected by the work. Sufficient lighting, road signs, barricades and traffic diversion signs must be established along the sites of the works in accordance with the Traffic Police requirements and to the entire satisfaction of the Engineer.

The Contractor shall also comply with the conditions imposed by Traffic Police and Roads Opening Conditions and Requirements stipulated by any other Authority.

Upon the completion of the pipeline or Machineholes, the Contractor shall backfill and make good all disturbances to the road, side table, road kerb and drains to the satisfaction of the Authorities and the Engineer.

If required the pits shall be covered with decking plates with appropriate support so that all traffic shall be allowed to run over the decking. No extra payment shall be admissible for such arrangements and the contractor's rates shall be deemed to cover such requirement. If directed by the authorities or the Engineer, the Contractor shall construct temporary diversion roads at his own cost to allow the traffic to flow through during the construction.

9.9.24 Partial Covering up of Road in Busy Areas

Where it is unavoidable to locate machinehole shafts or working shafts for tunnels in busy roads, the top of the openings shall be covered by decking, leaving only the minimum required area open at the top to carry out work within the shaft. Vehicles shall be permitted to travel over such covers provided. The Contractor shall submit to the Engineer details of the partial covering. He shall allow for compliance of this requirement in his rates.

9.9.25 Reinstatement of Road and affected Surfaces

The Contractor shall carry out the reinstatement of road foundation and road surface in accordance with the Specifications and requirements of the Engineer and as stipulated in the contract specifications. This shall include machine-paving as and when directed by the Engineer. Where road markings are affected, the Contractor shall reinstate with thermoplastic instead of paintings to the satisfaction of the Engineer.

9.9.26 Safety

The Contractor shall provide adequate ventilation and efficient apparatus to keep all excavations, tunnels and pipelines free from all dangerous gases, whether generated in the soil strata or otherwise, and he shall take precaution to ascertain that they are in a safe condition before allowing his workmen to descend.

While working in existing pipeline or machinehole , the Contractor shall provide air blowers to ventilate the place as sewage gas usually contains a high proportion of hydrogen sulphide, methane and other toxic gases which in combination with oxygen is explosive. Approved gas monitors/detectors and oxygen meters shall be used to ensure that the place is free from all dangerous gases. The Contractor is required to appoint a Health and Safety Engineer (Accident Prevention Officer) to ascertain that the pipeline or machinehole is in a safe condition before allowing his workmen to descend and work. No smoking or naked flame shall be allowed in the pipeline or machinehole . Monitoring of the air quality shall also be carried out regularly by the Contractor's supervisor while work is in progress and work shall be immediately suspended should unsafe conditions develop.

The Contractor is warned that besides performing any work in existing pipeline or machinehole , connecting to or breaking into existing pipeline or machinehole also poses potentially hazardous conditions. The existing pipeline or machinehole to which connection is to be made should therefore be thoroughly ventilated and certified as safe by the Supervisor/ Safety officer before workmen are allowed to execute the connection.

The Contractor and his Supervisor/ Safety officer shall be solely responsible for safety of persons entering in to the pipelines or confined spaces like Machineholes/ pits.

9.9.27 Continuous working

If, in the opinion of the Engineer it is necessary, by reason of the safety of the works, or the restoration of interrupted services or for any other reason whatever, the Contractor shall, when so ordered carry out the works or any portion thereof continuously by day and by night without extra charge and allow for such a contingency in his Bid price.

It shall be clearly and definitely understood by the Contractor that no claims in respect of any of the above shall be allowed in the settlement of the Final Account.

9.9.28 Steel trenching works

Wherever the sub-soil conditions are expected to be of a soft and unstable character, the normal methods of timbering may prove insufficient to prevent subsidence of the adjoining road surfaces, drains and canal and other services or adjoining buildings and structures, in such circumstances the Contractor will be required to use steel trench sheeting or steel sheet piling adequately supported by timber or steel struts, walling, etc.

Steel sheet piles shall conform to the provision of I. S 2314 or B.S. 4360 and shall be driven where required as directed by the Engineer.

The Contractor will be required to design the layout of the piling and the overall dimensions of the excavation to suit the sheets and corners available and to give sufficient working space for the proper construction of the work.

The Contractor will be expected to supply, pitch, drive and subsequently remove trench sheeting or piling in accordance with other items of the Specification and the terms “timber” or “timbering” shall also apply to steel trench sheeting or steel sheet piling throughout.

Alternatively, the Contractor may use trench boxes capable of supporting the ground in the given conditions. However, no extra payment shall be made on this account.

Contractors shall be solely responsible for design, installation and removal of any shoring or timbering or sheeting system and their adequacy and safety. The rates quoted by the Contractors shall be inclusive of such measures of providing steel sheeting or sheet piling.

9.9.29 Sewage in the connecting sewers

The pipelines installed under this Contract are meant to connect to the existing functioning upstream and downstream functioning sewers. These pipelines are carrying sewage (stagnant or flowing) and may also be in surcharged conditions at times.

9.9.30 Connection to existing sewers

The Contractor shall note that the connecting pipelines/ branches might have been laid sometimes back and would be full of stagnant sewage/ water and might also have some unknown connections. The methods adopted by the contractor for making connections of such lines shall take due cognizance of such circumstances as no extra payment shall be made on such account.

The Contractor shall note that in connecting pipelines to existing sewers, every care shall be taken to ensure that the connections are watertight and the existing pipelines are not damaged. Special precautionary measures shall be taken to ensure the stability of the pipelines connected to them.

The Contractor shall ensure that there is no interruption to existing flows during the connection works. No debris shall be allowed to fall or be discharged into the existing pipelines or Machineholes. Any debris which falls into the existing pipeline/ Machineholes and any obstructions thereby caused shall be removed at the Contractor’s expense immediately.

All connection to existing pipelines shall be subject to water tightness test and must meet the requirement for the same.

It shall be noted that during connecting the newly laid sewer line to the existing sewer, or for connecting cross sewers to the newly laid sewer, or to repair existing sewer, the contractors shall make necessary arrangement at his own cost, to procure Pneumatic plug / Inflatable plug / mechanical plug / Pillow plug for plugging existing sewer line. Plugging existing sewer by using mud / sand filled gunny bags will not be permitted. Plugging shall be done in co-ordination with & as directed by concerned staff of Main Sewer Dept of BWSSB.

Safety measures for use of Sewer Plugs - Contractors need to ensure that the sewer plug is inspected prior to each use. The plug shall be partially inflated and inspected under low pressure for any obvious wear, tear, cuts, abrasions or damage. Also, examine the accessories with which the PLUG is to be inflated.

Inflation pressures as in the Manufacturer's instruction manual and on the plug, must be adhered to when inflating the plug, but never exceeds the max. Working pressure. Check the internal pressure in the PLUG regularly.

Utilizing an air line extension plugs can be inflated from a distance, away from the danger zone or outside

The PLUGS shall only be used by persons who have been properly instructed and who are trained for the use.

When using the PLUGS, the safety of the user and any bystanders must always be borne in mind, as wrong use can cause life threatening situations.

Contractors shall consider measures to brace for and absorb the impact of plug failures and to prevent the PLUG from sliding out. This may include anchored ropes/cables in upstream Machineholes, bracing in the chase of the plugged machinehole , or a combination of methods, all with associated risk assessments and controls in place.

Ensure only the use of approved and calibrated pressure gauges. And also ensure pressures are monitored and controlled during plug inflation / deflation with calibrated gauges.

The Contractor shall allow for all the above in his rates.

9.9.31 Laying pipelines in residential areas

The Contractor shall note that if the pipeline has to be laid in close proximity to existing premises. He shall take all necessary precautions, including the provision of steel sheet piling cut-off walls where necessary, to prevent any damage to the existing premises and shall be responsible for the damage and complete repairs of the same.

The Contractor shall be responsible for obtaining permissions from the owners of private premises if needed by him for his work. He shall be responsible for restricting his workmen to the site of the work while working in private premises. If the Contractor considers it essential to have additional working space he may obtain the same from private property owners entirely at his risk and cost. The Engineer is not bound to arrange for such facilities from private property owners.

Temporary fencing shall be erected as directed by the engineer to separate the worksite from the rest of the private premises at the Contractor's own expense for all execution.

Turf, walls, slopes, fencing, shed or any other structures whether directly or otherwise disturbed or damaged by the construction work shall be reinstated to the original conditions by the Contractor at his own expense.

The Contractor shall allow in his rates for complying with these requirements as no claim to the contrary will be entertained by the Employer/ Engineer.

9.9.32 Hydraulic testing of Sewer line & Handing over of completed works

Upon completion of works the sewer lines including rising mains shall be hydraulically tested as per the required head/ pressure as per CPHEEO manual provision of specifications. After successful testing, the contractors must clean the site as per the satisfaction of the Engineer and the same shall be handed over by the contractor to the user department under proper acknowledgement and certificate to this effect.

Hydraulic testing and cleaning up the site on completion is to be done by the contractors at his own cost and no extra payment shall be admissible for this requirement.

All works to be water tight

(a) The drains, Machineholes and all joints of pipes must be made thoroughly sound and water tight, and any joint which may be proved to be leaky at any time during the progress of the works or during the contractors' subsequent period of maintenance shall be immediately made sound by the contractors at their own expense. The contractors, when required by the Engineer shall at their own cost prove all works to be water tight by filling it with water to such height as the Engineer may determine. Any additional precautionary measure or appliances that may be found necessary to ensure the water tightness of the Machineholes, flush tanks, disc plug in junctions and the joints of pipes shall be adopted by the Contractor without extra charge, the responsibility of making them completely water tight resting upon the contractors.

Complete sewer inspection of inside of pipe shall be carried out with help of CCTV sewer inspection camera and a record of the same shall be maintained in the form of CCTV footage with proper indexing/ subtitles/ overlays etc and submitted to the Engineer (3 copies) on DVDs.

(b) Immediately after the CCTV pipe inspection has been completed and any defect discovered therein has been made good the Contractor shall prove the joints of the stretch of under-ground carrier pipes, to be water tight by filing in pipes with water before filling in the trench to the level of 1.50 M above the top of the highest pipe in the stretch and heading the water up for the period of one hour or such further time as the Engineer may direct. The apparatus used for the purposes of testing shall be approved by the Engineer. The contractor if required by the Engineer shall make the excavation dry and keep it so during the period of testing. No test applied to part of a stretch of pipes shall be considered conclusive nor shall it be deemed to obviate the necessity of an application of the test to the whole of stretch when completed. The loss of water (ex-filtration) or rise in water volume (infiltration) over a period of 30 minutes should be measured by adding water from a measuring vessel at regular 10 minutes and noting the quantity required to maintain the original water level. For the purposes of this test the average quantity added should not exceed 1 litre/hour/100 linear metres/10 mm. of nominal internal diameter.

Works not within above specified requirements shall stand rejected and shall be rectified by the

Contractor at his risk and cost.

The Machineholes when they have been raised above the highest subsoil water level expected in the monsoon shall similarly be tested for water tightness as for the pipelines. The procedure for this shall be as follows:-

The mouths of all pipes entering the machinehole shall be suitably plugged with brick, masonry or wooden or any other type of plug. The machinehole under test shall then be filled with water up to the general sub-soil water level and observed for a period of one hour. If the level does not drop by more than 50 mm. in one hour it shall be assumed that the machinehole is water tight.

Note for pipe laid by open trenching only: During the period of the test the outside trench shall be kept free from any accumulation of subsoil water in case of a drop of more than 50 mm in the water level the contractor shall note the places from where the leakage is taking place & take steps to stop the leakage.

(c) Cleaning of the pipes

The open end of an incomplete stretch of pipeline shall be securely closed as may be directed by the Engineer to prevent entry of mud or silt etc.

(d) If as a result of the removal of any obstruction the Engineer considers that damages may have been caused to the pipelines, he shall be entitled to order the length to be retested at the expense of the Contractor. Should such retest prove unsatisfactory, the contractor shall at his own expense amend the work and carry out such further tests as are required by the Engineer.

(e) It shall also be ascertained by the Contractors that each stretch from machinehole to machinehole is absolute clear and without any obstruction by means of CCTV inspection of the interior of the pipeline.

All works to be clear, clean and perfect

The contractors shall after completion or whenever required by the Engineer, prove all pipes and fitting to be clear clean and perfect, and for this purpose shall, at their own expense and in the presence of the Engineer or his appointee, provide suitable instruments and appliances and pass them through the pipes and shall if required, throw in water and show that it passes freely through every portion of the work. Brick, mortar and rubbish shall not be allowed to fall into the Machineholes of sewer lines while fixing or if allowed, shall be removed by the Contractors at their own expense.

Remedial Measures to be adopted by the Contractor

The Contractor shall take each and every precaution to ensure that the tunnelling or drilling equipment will successfully excavate along the chosen pipeline alignment before he commences the operation. In the event of inability to complete the drive, due to break down or any other reasons, the Contractor shall be fully responsible to recover the equipment safely from the ground and restore the incomplete work to the original condition at his risk and cost by a method agreed with the Engineer and the concerned authorities within the time stipulated by the Engineer or the concerned authority.
The cost for such retrieval measures or any consequential expenditure or delays arising from thereof shall be entirely borne by the Contractor. Any failure of remedial measures shall be entirely at the risk and cost of the Contractor. Any abandoned hole or tunnel must be backfilled to the top of the hard

strata with concrete or gravel with grouting to provide a solid infill, or other method agreed with the Engineer completely at the Contractor's cost so as to prevent subsequent settlement.

Inspection and Replacement of Defective Work

(a) At any time during or after the execution of the Works the Contractor shall, at the request of the Engineer and within such time as the Engineer shall name, open for inspection any work covered up and should the Contractor refuse or neglect to comply with such request, he shall employ other workmen to open up same.

(b) If the said work has been covered up in contravention of the Engineer's instructions, or if on being opened up it be found not in accordance with the Drawings, Specification and Bills of Quantities or the instructions of the Engineer, the expenses of such opening and covering it up again, whether done by the Contractor or such other workmen, will be borne by and is recoverable from the Contractor.

(c) Wherever in the opinion of the Engineer the work done is inadequate or of poor workmanship or inferior materials or in any way sub-standard such works will be demolished, cut out and removed from the Works immediately and replaced with new materials of the required standard and quality at the Contractor's risk and cost.

Taking photographs

Contractor at his own cost shall take, print, supply album of photographs (Two sets) in an album during the construction work in progress. The photographs shall be submitted fortnightly or as directed by the Engineer. No extra payment shall be admissible for this requirement.

CCTV Survey

It is mandatory for the contractor to carry out CC TV Survey including submission of two soft copies & two hard copies to the Engineer after completion of particular drive / work along with Machineholes or as directed by the Engineer. No extra payment shall be admissible for this requirement.

Handing over of completed works

Any pipe or length of pipes found to be defective shall be immediately removed and replaced at the Contractor's expense and leaking joints shall be remade, the inspections and tests shall then be repeated as often as necessary until the whole line under inspection or test is accepted by the Engineer. Upon completion works and successful testing of completed works the same shall be handed over by the contractor to the user department under proper acknowledgement and certificate to this effect.

End of Part-11

PART 14

INSPECTION, TESTING AND COMMISSIONING REQUIREMENTS

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PART-14

INSPECTION, TESTING AND COMMISSIONING REQUIREMENTS

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PART 14

INSPECTION, TESTING AND COMMISSIONING REQUIREMENTS

14.1 Inspection and Testing During Manufacture

14.1.1 General

(a) All inspection and testing shall be carried out in accordance with the Specification and in the absence of Specification relevant Indian Standard or internationally approved equivalent standard. After award of Contract, Contractor shall furnish a QA plan for approval by Employer. QA plan shall include testing for incoming supply of raw materials and bought out items, stage inspections and tests on finished products at manufacturer's works / appropriate testing station. QA plan shall clearly indicate tests which are intended to be witnessed by the Contractor alone and those by both Contractor and Employer.

(b) **Inspection and tests schedule shall be as follows**

1) Manufacture tests
2) Acceptance inspection / Quantity checking
3) Install / site inspection
4) Wet Tests (by Raw Sewage)
5) Test furnished as per IS Code/manufacturer QAP

(c) The Contractor shall carry out at the place of manufacture tests of the Plant /Equipment at any part of the Works as per approved QAP.

(d) The Employer and/or duly authorised and designated representative(s) shall be entitled to attend the aforesaid inspection and/or tests.

(e) The Employer and his duly authorised representative shall have access to the Contractor's premises at all times to inspect and examine the material and workmanship of the mechanical and electrical plant and equipment during its manufacture there. If part of the plant and equipment is being manufactured on other premises, the Contractor shall obtain permission for the Employer or his duly authorised representative, to inspect as if the plant and equipment was manufactured on the Contractor's own premises. Testing (including testing for chemical analysis and physical properties) shall be carried out by the Contractor and certificates submitted to the Engineer who will have the right to witness or inspect the above-mentioned inspection /testing at any stage desired by him. Where inspection or testing is to be carried out at a subcontractor's works, a representative of the Contractor shall be present.

(f) Contractor shall provide test procedure, pre-factory test results, and calculation sheet, photo in advance, and provide all test results with necessary documents, including its data and photo, to show the Engineer that the test is carried out in proper condition and its test results. Construction material shall be tested by Contractor at the approved laboratory

(g) The procedure for testing and inspection to be carried out during or following the manufacture of the materials, to ensure their quality and workmanship, and to further ensure that they conform to the Contract, shall be as described below.

(i) The Contractor shall provide the Employer with at least 21 clear days' written notice of the date and location at which any plant or equipment will be ready for inspection and testing, as specified in the Contract. Prior to notice, the Contractor should submit pre-factory test results as per clause 14.1.1(f). The Employer or his duly authorised representative shall thereupon, at his discretion, notify the Contractor of his intention either to release such part of the plant and equipment upon receipt of works tests certificates or of his intention to inspect. The employer shall then give notice in writing to the Contractor and attend at the place so named the said plant and equipment which will be ready for inspection and/or testing. As soon as any plant has passed the tests referred to in this section, the Engineer shall issue a notification to that effect to the Contractor, after obtaining clearance from the consultants.

(ii) The Contractor shall forward to the Employer 6 duly certified copies of the test certificates along with characteristics performance curves/tables if any for all equipment obtaining dispatch clearance from the consultants/Engineer.

(iii) If the Engineer(s) fails to attend the inspection and/or test, or if it is agreed between the parties that the Engineer(s) shall not do so, then the Contractor may proceed with the inspection and/or test in the absence of the Engineer and provide the Employer with a certified report of the results thereof as per (ii) above.

(iv) If any materials or any part of the works fails to pass any inspection / test, the Contractor shall rectify or replace such materials or part of the works and shall repeat the inspection and/or test upon giving a notice as per (i) above. Any fault or shortcoming found during any inspection or test shall be rectified to the satisfaction of the Engineer before proceeding with further inspection of that item. Any circuit previously tested, which may have been affected by the rectification work, shall be re-tested.

(v) Where the plant and equipment are a composite unit of several individual pieces manufactured in different places, it shall be assembled and tested as one complete working unit, at the manufacturer’s works.

(vi) Neither the execution of an inspection test of materials or any part of the works, nor the attendance by the Engineer(s) nor the issue of any test certificate pursuant to (iii) above shall relieve the Contractor from his responsibilities under the Contract.

(vii) The test equipment, meters, instruments etc., used for testing shall be calibrated at recognised test laboratories at regular intervals and valid certificates shall be made available to the Engineers at the time of testing. The calibrating instrument used as standards shall be traceable to National/International standards. Calibration certificates or test instruments shall be produced from a recognised/Laboratory for the Engineer’s consent in advance of testing and if necessary, instruments shall be recalibrated or substituted before the commencement of the test.

(viii) Items of plant or control systems not covered by standards shall be tested in accordance with the details and program agreed between the Engineer and Contractor’s Representative. If such materials or works are found to be defective or not conforming to the Contract requirements, due to the fault of the Contractor or his sub-contractors the Contractor shall defray all the expenses of such inspection and/or test and of satisfactory reconstruction.

(ix) Tests shall also be carried out such that due consideration is given to the site conditions under which the equipment is required to function. The test certificates shall give all details of such tests.

(x) The Contractor shall establish and submit a detailed procedure for the inspection of materials or any part of the works to the Employer for approval within the date indicated in the Programme Details. The detailed procedure shall indicate or specify, without limitation, the following:

- Applicable code, standard, and regulations.
- Fabrication sequence flow chart indicating tests and inspection points.
- Detailed tests and inspection method, indicating the measuring apparatus to be used, items to be measured, calculation formula, etc.
- Acceptance criteria.
- Test report forms and required code certificates and data records.
- Method of sampling if any sampling test to be conducted.
- Contractor's or Employer's witness points.

(xi) The Contractor shall not pack for shipment any part of the Plant until he has obtained from the Employer or his authorised representative his written approval to the release of such part for shipment after any tests required by the Contract have been completed to the Employer's satisfaction.

(xii) The following Inspection and Testing procedures shall be carried out for the equipment as per approved QAP. The detailed procedure shall indicate or specify, without limitation, the following:

- Raw Material
- Visual Inspection/Appearance.
- Chemical and Mechanical property tests
- Dimension Checking
- Dynamic balancing for all rotating parts
- Stage inspection
- Hydrostatic / Leak testing for all pressure parts, Pneumatic Leak Test wherever applicable
- Repair procedure
- Operation check
- Procedure Qualification Record (PQR); Welding Procedure Qualification (WPQ) and Welders Qualification Report (WQR)
- Material Test
- Assembly/Connection
- Documentation

(h) The Contractor shall maintain proper identification of all materials used, along with reports for all internal / stage inspection work carried out, based on the specific job requirement and or based on the datasheets / drawings / specifications.

(i) The expenses incurred during inspection shall include, but not be limited to, travel, boarding, lodging, and out-of-pocket expenses.

(1) The Contractor shall be responsible for all expenses incurred by the Engineer or person/s nominated by the Engineer in attending inspection and tests of Plant carried out during manufacture within India and abroad. Two persons from Employer side will witness the Inspection and testing along with the Contractor's representative. No separate payment will be made against to the inspection & testing, and same shall be included in bidder's quoted price.

(2) The cost of inspection when the material or any part of the facilities is not ready at the time specified by the Contractor for inspection, or when re-inspection is necessitated by prior rejection, shall also be borne by the Contractor.

(3) During all factory inspections, the authorized Contractor's representative should be present, along with the Employer and the third party. The authorized Contractor person who is attending the inspection shall be a qualified factory inspector based on the type of inspection.

(j) Witnessed testing will normally be waived on standard types of equipment such as small motors made by approved manufacturers, individual standardised instruments, small mass-produced components used in the manufacture of Plant items, small bore pipe work and fittings, minor installation materials and low voltage cable. In order to remove doubt this shall not relieve the Contractor of his obligation under the Contract to ensure that all Plant is tested at the manufacturer's works prior to delivery to Site.

(k) As a guide to the Contractor the Employer reserves the right to witness testing of the following but not limited to the following Plant items:

14.1.2 Materials, Plant and Equipment

The Contractor shall place orders for the material and the equipment only after approval of QAP by the Engineer. The Contractor shall submit the detailed technical and its drawings from the approved manufacturer and the procedure of submission, review and revision shall be as specified herein below.

The Contractor shall inform the Employer about the likely dates of manufacturing, testing, and dispatching of any material and equipment to be incorporated into the Permanent Works. The Contractor shall notify the Employer for inspection and testing, at least twenty-eight (28) days prior to packing and shipping and shall supply the manufacturer's test results and quality control certificates.

The testing and approval for dispatching shall not absolve the Contractor from his obligations for satisfactory performance of the plant.

Dispatch Clearance

All mechanical/electrical/instrumentation equipment shall be tested at their respective factory which will be witnessed by tri parties (Contractor, BWSSB/Consultant inspecting team) in line with approved QAP and Equipment Data sheet.

The test observation sheets, material tests certificates (chemical and mechanical test at laboratory) and joint inspection report shall be signed by the Contractor, BWSSB/Consultant officials after successful completion of the tests.

Contractor shall forward all original reports to BWSSB and copy to the consultant for verification and issuance of Dispatch Clearance Certificates as per clause 14.1.1 g (ii). No Dispatch Clearance Certificate will be issued by the inspecting agency at the factory.

14.1.3 Factory Acceptance Test (FAT) Document

Fifty-six (56) days prior to commencement of inspection of each Plant item / equipment the Contractor shall supply a Factory Acceptance Test (FAT) Document for approval. This shall comprise four copies of the following:

- Unpriced copy of the Contractors order for the Plant item / equipment concerned:
- Details of the inspection and test procedures to be carried out.
- Pre-factory test results and its photos.

The FAT Plan shall provide comprehensive details of the tests to be carried out, the purpose of each test, the equipment to be used in carrying out the test and the methods to be adopted in carrying out the tests. The FAT shall provide space within the documentation for results of the tests to be added and for each test and for the FAT as a whole to be signed off by the Contractor and the Engineer.

On completion of the tests, the Contractor shall provide four (4) copies of all test certificates, etc. for the inspected Plant item. To remove doubt test certificates shall be provided for the Plant item as a whole plus certificates for the relevant component parts such as:

14.1.4 Inspection and Testing Programme

The Contractor shall submit to the Engineer no later than 56 days prior to the commencement of the first inspection and test during manufacture a programme detailing the inspection dates for all Plant. Those items of Plant that the Engineer has specifically identified for witness testing shall be highlighted in the programme.

The Contractor shall keep the Engineer informed of any changes to the programme.

The Engineer shall not be requested to inspect an item of Plant until the Contractor has satisfied himself that the equipment meets all requirements of the Employer’s Requirements.

The Contractor shall inform the Engineer in writing at least 21 days in advance regarding readiness for carrying out inspection of equipment/material etc. at manufacturer's works or at places of inspection. The programme for inspection shall be finalised by the Engineer after the receipt of the above case equipment/material etc. Is found not to comply with the specification, the dates for re-inspection shall be finalised and expenses incurred by the Employer for such visits shall also be recovered from the Contractor. Contractor's Representatives shall essentially be present during all inspections of Plant items. The following information shall be given in the inspection call letter mentioned above:

(a) Name of manufacturer/supplier

(b) Address of place where inspection is to be carried out

(c) Proposed date/s and equipment to be inspected

(d) Name/s of contact personnel at manufacturer's/ supplier/s works with their telephone and fax numbers.

(e) Name of Contractor's Representative who will be present during the inspection.

(f) Confirmation that internal testing has been completed. Submission of internal testing report for review before visiting the plant

The Contractor shall provide all the necessary instruments, test facility, water / electric power, test piece, samples, engineers/ workers, all cost, and others to carry out the tests after assembly. All instruments used for such tests shall be calibrated and certified by, and approved by, an independent testing authority within one month prior to the tests in which they are used. Calibration certificates with an expiration date and the name of the authorization agency for instruments used in such tests shall be produced for

the Engineer's approval, and if necessary, instruments shall be recalibrated before the commencement of the tests.

No material shall be delivered to the Site without a Dispatch clearance certificate having been carried out or waived in writing by the Engineer.

If, during or after testing, any item of plant fails to achieve its intended purpose or otherwise proves defective, it shall be modified or altered as necessary and retested and reinspected as required by the Engineer.

14.1.4.1 Pipe-work

The following tests shall be carried out:
(a) Material identification
(b) Welder qualification
(c) Edge preparation and weld set up
(d) Back chip where applicable
(e) Mechanical tests/production control test coupon tests
(f) NDT as required

The welding shall be checked by ultrasonic testing for all length, i.e. 100 % testing at the place of manufacture. Additionally, 10% of the weld joints shall be tested by radiography. All specials shall be tested 100% by radiography.

Testing of pipes and fitting shall be carried out in accordance with relevant Indian Standard and internationally approved standard. Pipes, fittings and expansion bellows shall be hydrostatically tested for 1.5 times the rated pressure. For all the tests specified, the certificates and shop records shall be duly approved and certified by the manufacturer, and these shall be subject to review & approval by Employer / Engineer.

14.2 Reinforced Cement Concrete Pipes- Factory Testing

(1) All pipes for testing purposes shall be selected at random from the stock of the manufacturer and shall be such as would not otherwise be rejected under the criteria of tolerances as mentioned in IS: 458.

(2) Contractor shall provide laboratory test /analysis results of cement and aggregate component and cement vs. aggregate vs. water mixing ratio and concrete mixing time and mixing method.

(3) During manufacture, tests on concrete shall be carried out as per IS:456. The manufacturer shall supply, when required to do so by the Engineer the results of compressive tests of concrete cubes and split tensile tests of concrete cylinders made from the concrete used for the pipes. The manufacturer shall supply cylinders or cubes for test purposes required by the Engineer and such cylinders or cubes shall withstand the tests prescribed as per IS:458. Every pressure pipe shall be tested by the manufacturer for the hydrostatic test pressure. For non-pressure pipes, 2 percent of the pipes shall be tested for hydrostatic test pressure.

(4) The specimen of pipes for the following tests shall be selected in accordance with relevant clause of IS: 458 and tests in accordance with the methods described in IS: 3597.

(1) Hydrostatic test

(2) Three edge bearing test
(3) Absorption test
(4) Dimension and colour of surface
(5) Damage

14.3 Sampling and Inspection

(1) In any consignment, all the pipes of same class and size and manufactured under similar conditions of production shall be grouped together to constitute a lot. The conformity of a lot to the requirements of this Employer's Requirements shall be ascertained on the basis of tests on pipes selected from it.

(2) The number of pipes to be selected from the lot for testing shall be in accordance with Table 15 of IS:458.

(3) Pipes shall be selected at random. In order to ensure randomness, all the pipes in the lot may be arranged in a serial order and starting from any pipe, every r-th pipe be selected till the requisite number is obtained, r being the integral part of N/n where N is the lot size and n is the sample size.

(4) All pipes selected shall be inspected for dimensional requirements, finish and deviation from straight. A pipe failing to satisfy one or more of these requirements shall be considered as defective.

(5) The number of pipes to be tested shall be in accordance with column 4 of Table 15 of IS:458. These pipes shall be selected from pipes that have satisfied the requirements mentioned in the above clause.

(6) A lot shall be considered as conforming to the requirements of IS:458 if the following conditions are satisfied.

(7) The number of defective pipes shall not be more than the permissible number given in column 3 of Table 15 of IS:458.

(8) All the pipes tested for various tests shall satisfy corresponding requirements of the tests.

(9) In case the number of pipes not satisfying requirements of any one or more tests, one or two further samples of same size shall be selected and tested for the test or tests in which the failure has occurred. All these pipes shall satisfy the corresponding requirements of the test.

(10) All destructively tested samples shall be replaced to new.

14.4 Cast Iron / Ductile Iron Pipes

Mechanical Tests

Mechanical chemical tests shall be carried out during manufacture of pipes and fittings as specified in relevant IS codes. The results so obtained shall be considered to represent all the pipes and fittings of different sizes manufactured during that period and the same shall be submitted to the Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per relevant IS codes.

Brinell hardness Test

For checking the Brinell hardness, the test shall be carried out on the test ring or bars cut from the pipes used for the ring test and tensile test in accordance with IS 1500.

Retests

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements, the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

Hydrostatic test

For hydrostatic test at works, the pipes and fittings shall be kept under test pressure as specified in relevant IS codes they may be struck moderately with a 700 g hammer. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. The hydrostatic test shall be conducted before coating the pipes and fittings.

14.5 Reinforced Cement Concrete Pipes-Site Testing

(a) After laying and jointing of RCC pipes is completed the pipeline shall be washed out with sufficient water and be tested at work site as per the Employer's Requirements and as directed by the Engineer. All equipment for testing at work site shall be supplied and erected by Contractor. Water for testing of pipes shall be arranged by him. Damage during testing shall be Contractor's responsibility and shall be rectified by him to full satisfaction of the Engineer. Water used for the test shall be removed from pipes and not released to the excavated trenches.

(b) After the joints have thoroughly set and have been checked by the Engineer and before back filling the trenches, the entire section of the sewer shall be proved by the Contractor to be water tight by filling in pipes with water to the level of 1.50m above the top of the highest pipe in the stretch and heading the water up for a period of one hour.

(c) The apparatus used for the purpose of testing shall be approved by the Engineer. Contractor if required by the Engineer shall dewater the excavated pit and keep it dry during the period of testing. The loss of water over a period of 30 minutes should be measured by adding water from a measuring vessel at regular 10 minutes intervals and noting the quantity required to maintain the original water level. For the approval of this test the average quantity added should not exceed 1 litre/ hour/100 linear metres / 10mm of nominal internal diameter. Any leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work should be removed and made good.

(d) In case of pressure pipeline, the completed stretch of pipeline shall be tested for site test pressure. The site test pressure should not be less than the maximum operating pressure plus the calculated surge pressure, but in no case should it exceed the hydrostatic test pressure as specified in IS: 458.

14.6 Cast Iron, Ductile Iron Pipes and Fittings-Site Testing

(a) After the pipes and fittings are laid, jointed and the trench partially backfilled except at the joints the stretch of pipe line as directed by Engineer shall be subjected to pressure test and leakage test after washing the pipe line out with sufficient water.

Where any section of the pipeline is provided with concrete thrust blocks or anchorages, the pressure test shall not be made until at least five days have elapsed after the concrete was cast. If rapid hardening cement has been used in these blocks or anchorages, the tests shall not be made until at-least two days have elapsed.

(b) Each section of the pipe line shall be slowly filled with water and all air shall be expelled from the pipe by tapping at points of highest elevation before the test is made and plugs inserted after the tests have been completed. The specified test pressure based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge shall be applied by means of a pump connected to the pipe as directed by the Engineer.

(c) The duration of test shall not be less than 5 minutes. The exposed joint shall be carefully examined and all such joints showing visible leaks shall be re-caulked until water tight. Any cracked or defective pipes and fittings in consequence of this pressure test shall be removed and replaced by sound material by Contractor at no extra cost to the Engineer and the test shall be repeated to the satisfaction of the Engineer.

(d) After the satisfactory completion of pressure test, the section of pipeline shall be subjected to leakage test. The duration of test shall be 2 hours. No pipe installation shall be accepted until the leakage is less than the number of cm^3 /h as determined by the formula:

$$q_L = \frac{ND\sqrt{P}}{3.3}$$

Where,

q_L	=	The allowable leakage in cm^3/hr
N	=	Number of joints in the length of the pipeline
D	=	Diameter in mm, and
P	=	The average test pressure during the leakage test in Kg/cm^2

Should any test of pipe laid indicate leakage greater than that specified above, the defective joints shall be repaired by Contractor at no extra cost to the Engineer until the leakage is within the specified allowance.

(e) Necessary equipment and water used for testing shall be arranged by Contractor at his own cost. Damage during testing shall be Contractor's responsibility and shall be rectified by him at no extra cost to the Engineer. Water used for testing shall be removed from the pipe and not released in the excavated trenches.

(f) After the tests mentioned above are completed to the satisfaction of the Engineer, the backfilling of trenches shall be done as per the Employer’s Requirements specified elsewhere.

Contractor's Equipment, materials and appurtenances

The Contractor shall have available on the Site sufficient suitable equipment and machinery, as well as all other materials and appurtenances required by him, of ample capacity to ensure the proper erection of Plant and to handle any emergencies such as may normally be expected in work of this character.

The Contractor shall be responsible if any installation materials are lost or damaged during installation. All damages and thefts of equipment/component parts, after takeover by the Contractor, till the installation is taken over by Employer shall be made good by the Contractor to the satisfaction of Engineer.

Workmanship

Plant shall be erected in a neat and workmanlike manner on the foundation and at the locations and elevations shown on the approved drawings and other Engineering documents. Unless otherwise directed by the Engineer the Contractor shall adhere strictly to the aforesaid drawings and no departures there from will be permitted.

All plant shall be correctly aligned, leveled and adjusted for satisfactory operation and shall be installed so that the proper and satisfactory connection can be made readily between the various units and pipe work and equipment installed under the Contract. The mounting arrangements for pump sets and blowers shall be such that the alignment offset between motors and the driven equipment shall be well within 0.1 mm.

Building-in

Erection of Plant shall be phased in such a manner so as not to obstruct the work being done by other Contractors. Before commencing any erection work, the Contractor shall check the dimensions of structures where the various items of plant are to be installed, and shall bring any deviations from the required positions, lined or dimensions to the notice of the Engineer and shall take such measures as are necessary for their correction.

The Contractor shall take particular care for the correct positioning and alignment of all puddle pipes which are required through concrete structures prior to, and during the pouring of concrete.

The Contractor shall pin and plug in the holes prepared, all small clips, plugs, screws, nails, sleeves, inserts, etc., required for fixing electric wires and conduits, small pipe work and all other apparatus.

The Contractor shall align all equipment and holding down bolts and shall inform the Engineer before proceeding with grouting-in the item or item concerned. The Contractor shall ensure that all equipment is securely held and remain in correct alignment before, during and after grouting-in.

The Contractor shall properly bed in cement grout each item of plant or its supporting base resting on foundations and shall grout-in where required holding down bolts placed in the holes prepared in the foundations. The materials and workmanship used in grouting shall be such as will result in a solid anchoring of foundation bolts and complete filling of the gaps between the Plant or its base and the foundations, without shrinkage or cracking.

During erection of the Plant the Employer will inspect the installation from time to time in the presence of the Contractor's Site representative to establish conformity with the requirements of the Specification. Any deviations and deficiencies found, or evidence of unsatisfactory workmanship shall be corrected as instructed by the Employer.

All plant shall be installed in accordance with the recommendations or instructions of the manufacturer, for the application. Each mounting position shall be chosen to give correct operation of the equipment, ease of operation, access for maintenance and servicing and freedom from any condition which could have adverse effects.

In accordance with the specific installation instructions, as shown in Contractor's drawings or as directed by the Engineer's Representative the Contractor shall unload, erect, install, wire, test and place into commercial use of all electrical equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square, and properly aligned and oriented.

The Contractor shall furnish all supervision, labour, tools, equipment, rigging materials and incidental materials such as bolts, wedges, anchors, concrete inserts etc. required to completely install, test and adjust the equipment.

Drawings, instructions and recommendations shall be correctly followed in handling, settling, testing and commissioning of all equipment and care shall be exercised in handling to avoid distortion to stationary structures, the marring of finish, or damaging of delicate instruments or other electrical parts.

The Contractor shall erect and commission the equipment as per the instructions of the Engineer's Representative and shall extend all co-operations to him.

In case of any doubt/misunderstanding as to correct interpretation of drawings or instructions, necessary clarification shall be obtained from the Engineer's Representative. The Contractor shall be held responsible for any damage to the equipment consequent to not following instructions correctly.

The Contractor shall move all equipment into the respective buildings through regular doors or floor openings provided specifically for the equipment. The Contractor shall make his own arrangement for lifting of equipment.

Where assemblies are supplied in more than one section, the Contractor shall make all necessary mechanical and electrical connections between sections including the connections between bus bars/wires. The Contractor shall also carry out the adjustments/alignments necessary for proper operation of the circuit breakers. All insulators and bushings shall be protected against damage during installation. Insulators or bushings chipped, cracked or damaged due to negligence or carelessness shall be replaced by the Contractor at his own expenses.

The Contractor shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments or relays are supplied separately, they shall be mounted only after the associated control panels have been erected and aligned. The blocking material/mechanism employed for the safe transit of the instruments and relays shall be removed after ensuring that the panels have been completely installed and no further movement of the same would be necessary. Any damage to relays and instruments shall be immediately reported to the Engineer's Representative.

The Contractor shall carry-out switchyard installation as required in the plan and elevation drawings of switchyard showing bus bar configurations, sizes, tensions, insulator details, etc.

The Contractor shall install complete set of bus bars and all bays, conductors, complete with tension/suspension insulator strings, bus-post insulators, equipment connections, bus bar connections to equipment, lightning shield wires including down comers. The down comers shall be brought up to a height of 1000 mm from ground level where they shall be connected to the test links.

Installation works of breakers and isolators with all accessories wherever applicable shall include adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All insulators and bushings shall be protected against damage during installation. Insulators or bushings damaged due to negligence or carelessness of the Contractor shall be replaced by him at his expense.

Care shall be taken during handling of insulating oil to prevent ingress of moisture or foreign matter. In the testing, circulation, filtering, or otherwise handling of oil, rubber hose shall not be used. Circulation and filtering of oil, the heating of oil by regulated short-circuit current during drying runs and sampling and testing of oil shall be in accordance with the latest Code of Practice IS:10028.

Inspection, storage, installation, testing and commissioning of transformers shall be in accordance with the latest Indian Standards Code of Practice IS:10028. All commissioning tests as applicable, vide Appendix B of IS:10028 (Part II) shall be carried out.

Switchgear, relay and control panels shall be installed in accordance with the latest Indian Standard Code of Practice 10118. The switchgear panels shall be installed on finished surface or concrete or steel sills. The Contractor shall be required to install and align any channel sills which form part of the foundations. Tape or compound shall be applied where called for. The base of outdoor type units shall be sealed in an approved manner to prevent ingress of moisture.

All electrical installations shall be tested in accordance with the requirements provided in National Electrical Code, NEC SP:30-2023, Part I-General and Common Aspects, Section-17-Erection and pre-commissioning Testing of Installation.

After installation of all power and control wiring, the Contractor shall perform operating tests on all switchgear and panels to verify the proper operation of switchgear/panels and the correctness of the interconnections between various items of equipment. This shall be done by applying normal a-c or d-c voltage to the circuits and operating the equipment. Megger tests for insulation, polarity checks on the instrument transformers, operation tests on equipment, and installation tests shall be carried out by the Contractor who shall also make all necessary for proper functioning of the equipment.

Installation and testing of the battery and battery chargers shall be done in strict compliance with the applicable standards. Each cell shall be inspected for breakage and condition of cover seals as soon as received at site. The battery shall be set up on racks as soon as possible after receipt, utilising lifting devices. The cells shall not be lifted by the terminals. Contact surface of the battery terminals and intercell connectors shall be cleaned, coated with protective grease and assembled.

Each connection shall be properly tightened. Each cell shall be tested with a hydrometer and thermometer and the results logged. A freshening charge, if required, shall be added. When handed over to the Employer, the battery shall be fully charged, and the electrolyte shall be at the full level and of the specified specific gravity.

Equipment furnished with finished coats of paint shall be touched up by the Contractor if their surface is spoiled or marred while handling.

Foundation work and grouting-in of fixing bolts or channels for all transformers, switchgear, motors, and control panels will be carried out by the Contractor.

Precautions

The approval by the Engineer of the Contractor's proposals for rigging and hoisting of any item of plant into its final position shall not relieve the Contractor from his responsibility for avoiding damage to completed structures, parts or members thereof or other installed equipment. He shall at his own cost make good, repair or replace any damaged or injured items whether structural, mechanical, electrical, architectural, or of any other description, promptly and effectively to the satisfaction of the Engineer.

No plant or other loads shall be moved across the floors of structures without first covering the floors with timber of sufficient size so that applied loads will be transferred to floor beams and girders of steel or concrete. If it is required to reduce bending stresses or deflection, the beam and girders shall be provided with temporary supports. Any movement of Plant and other loads over the floor structures shall be subject to the prior approval of the Engineer.

14.7 Civil Inspection (Water Leakage Test)

14.7.1 Tanks and basins

Refer to Part 11 – Particular Civil and Structural Works Requirements of the Bid Document

14.7.2 Field Control Inspection

Contractor shall conduct periodic field control inspection to prevent any field accident. The Engineer shall joint field inspect or conduct unannounced inspections.

14.7.3 Inspection after Erection

After the erection of any item of Plant and its associated equipment has been completed, it shall be offered to the Engineer for inspection in its static state prior to commissioning the item.

Completion of erection and procedure prior to setting to work.

The mechanical completion of plant under erection shall be deemed to occur if all the units/systems of the Works are structurally and mechanically complete as noted below:

All rotary, static, structural equipment, piping, electrical/instrumentation and other equipment under the scope of the Contract have been erected, installed and grouted and are as per the specifications.

All systems have been washed/flushed/drained/boxed up where necessary.

All system testing including pressure, vacuum and nondestructive tests, no load tests and such other tests are completed with safety valves/relief valves set to operating conditions installed in position.

All panels, local control desks erected with power/control cable terminations with all continuity checks, insulation checks and other installation checks are carried out.

All electrical equipment after the completion of erection shall be tested as per the requirements of National Electrical Code SP:30-2023, Part 1, Section 17.

Prior to pre-commissioning checks, the Contractor shall erect the entire Plant and ensure readiness of civil works to the satisfaction of Employer, so that the Works are physically ready to undergo pre-commissioning checks. Pre-commissioning checks will include checks like no-load running of machinery, checks on instruments and electrical including calibration and loop checks, functional checks, inter-lock checks etc.

At the stage of mechanical completion of erection, the Contractor shall ensure that all the physical, aesthetic and workmanship aspects are totally complete and the Plant is fit and sound to undergo pre-commissioning checks.
The following documentation shall be completed before the Contractor notifies Mechanical Completion of Erection to the Employer

(a) All shop inspection records compiled and bound in 4 (four) copies.
(b) All erection and commissioning procedures duly approved.
(c) All instruction manuals in draft form - with each sheet bearing a stamp to indicate "DRAFT FOR REVIEW ONLY" submitted in 4 (four) copies.

Upon achieving mechanical completion, the Contractor shall notify the Employer of such completion of section/units/systems and readiness for inspection for acceptance of mechanical completion of erection. The Employer/ Engineer shall proceed with inspection of such sections/units/systems within 10 days of such notice.

Consequent to inspection, the Employer will inform the Contractor a list of deficiencies for rectification and the Contractor shall complete the rectification work within a jointly agreed period prior to start of pre- commissioning tests. The erection period allowed by the Contractor shall include all activities of mechanical completion as noted above.

14.8 Hydraulic Wet Test Requirements

Hydraulic wet tests shall be carried out on completion of dry tests.

Clear Water shall be used for hydraulic wet tests. The purpose of the tests is to prove the hydraulic performance of the Works. In order to demonstrate this, the Contractor shall ensure that each part of the Works is hydraulically loaded to its rated throughput for a period of at least four hours.

In order to ensure a sufficient supply of water to carry out these tests the Contractor shall provide all required facilities, including but not limited to any temporary facilities that may be required for storage and recycle of Clear Water or facilities for the disposal of the water off Site in an approved manner.

The following tests inter alia shall be carried out:

1. Pressure testing of all piped systems laid direct in ground in accordance with the relevant standards.
2. Fill all structures and check for leaks.
3. Filling of all storage vessels to check for leaks and distortion.
4. Running of all pumped systems in order to check for.

i) Correct functionality.
ii) Absence of leaks.
iii) Correct running temperatures.
iv) Smoothness of running and the absence of undue vibration or stress.
v) Check drive running currents.

5. Carry out calibration of instruments where appropriate.
6. Carry out valve operation, diversions etc. to fully hydraulically load each process element (or where there is a requirement to withstand an overload), overload each process element.
7. Demonstrate correct functionality of electrical, control and instrumentation systems.

The Contractor shall simulate the conditions that will prevail when operating as a process in order to demonstrate the correct functionality of process control loops etc.

During these tests a check on the performance of Plant shall be made to compare its site performance with the factory test data and to identify any constraints on performance due to site conditions.

14.9 Safety Audit

After satisfactory completion of hydraulic wet tests and prior to introduction of process fluid to the plant a safety audit shall be carried out to ensure compliance with the necessary requirement for safety

and for operation of Plant. The safety audit shall be documented. The safety audit document shall be approved by the Engineer prior to commencement of Plant commissioning.

14.10 Wet Tests (with Raw Sewage)

On approval by the Engineer the Contractor shall carry out process wet tests.

Raw Sewage shall be used as the main feed stock for process wet tests. These tests shall be carried out to demonstrate the process performance of the Works. In order to demonstrate this, the Contractor shall ensure that each part of the Works is loaded to its rated throughput (including a period of overload if required in order to demonstrate compliance with the Employer's Requirements) for a continuous stable operating period of not less than 48 hours. If necessary, Contractor shall create design loading conditions for testing purposes by testing fewer than the total number of installed units of process tanks or equipment at a time. In such cases, multiple tests shall be conducted to ensure that all installed units are tested.

The Contractor shall provide all required facilities for the disposal off Site in an approved manner.

The following tests inter alia shall be carried out:

(1) Check for leaks on vessels, structures, pumps and pipework.
(2) Running of all pumped systems in order to check for.
   - Correct functionality.
   - Absence of leaks.
   - Correct running temperatures.
   - Smoothness of running and the absence of undue vibration or stress.
   - Check drive running currents where the solution pumped is different from that pumped during hydraulic wet tests.
(3) Carry out calibration of instruments.
(4) Carry out valve operation, diversions etc. to fully hydraulically load each process element (or where there is a requirement to withstand an over load), overload each process element.
(5) Demonstrate correct functionality of electrical, control and instrumentation systems not checked during dry or hydraulic wet tests or which may have changed as a result of the different operating conditions now prevailing.

On completion of the tests on the various parts of the works the Contractor shall run the plant as a whole in order to demonstrate the full functionality and performance of the Works at various through put rates for a continuous period of not less than 30 days.

During the various process tests the Contractor shall perform sampling and analysis of all the process streams (locations) and parameters listed in the "Sampling/Analysis Locations and Frequencies" table provided in the "Tests after Completion" Section below. The frequencies listed in this table shall be followed for the Tests after Completion. However, for the Process Wet Tests performed as part of the Tests on Completion, the sampling frequency for all locations and all parameters shall not be less than once every hour. The Contractor shall demonstrate to the Engineer that the Works is functioning in accordance with the Employer's Requirements. Each sample shall comprise two 1 litre (minimum) quantities and shall be labelled to identify the contents, where taken and time and date. The flow recorded at the time of sampling shall also be indicated in the log book or record. One sample shall be used by the Contractor for his analysis; the other shall be handed over to the Engineer.

The Engineer reserves the right to take additional samples and to carry out his own tests or to check the samples taken by the Contractor.

The Engineer shall be given reasonable access to the premises where analysis is taking place in order to check on working practices and the procedures being adopted.

14.11 Co-operation with other Contractors in the Execution of their Tests

The Contractor shall, where required, assist other Contractors in carrying out their tests on completion and or tests after completion.

Where this assistance does not constitute part of the Contractors own work associated with Tests on Completion or Tests after Completion the Contractor shall be reimbursed at the rates approved by the Engineer.

14.12 Prices for Inspection, Testing and Commissioning

The Contractor, at the time of bidding, shall be responsible to ensure the completeness and adequacy of his Bid Price to full-fill the entire responsibilities as described above. His bid price, as quoted on in the Schedule of Prices, shall include all costs including but not limited to expenditure for personal, Prices for to-and-fro travelling, Prices for onsite Inspection, Testing and Commissioning site.

End of Part-14

PART 18

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

AND

ENVIRONMENTAL MONITORING PLAN (EMoP)

CONTENTS

PART 18

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

AND

ENVIRONMENTAL MONITORING PLAN (EMoP)

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PART -18
ENVIRONMENTAL MANAGEMENT PLAN (EMP)
AND
ENVIRONMENTAL MONITORING PLAN (EMoP)

18.1 General

Mitigation measures and monitoring for Environmental and Social considerations shall be carried out by the Contactor during the Construction and Operation Service Phases in accordance with the Environmental Management Plan (EMP) and the Environmental Monitoring Plan (EMoP). The results of monitoring will be provided to World Bank on a quarterly basis during the Construction Phase and biannually during the Operation Service Phase till the end of the Project. In case the results of monitoring contravene Indian and/or International Standards and/or tender requirements and/or significant adverse impact(s) is/are identified, necessary measures shall be taken by the Contractor with no additional cost.

18.2 Proposed Environmental Management Plan (EMP)

The Contractor shall carryout mitigation measures based on the proposed Environmental Management Plan (EMP) including indemnification as indicated below.

18.2.1 Construction Phase - EMP

S. No	Impacts	Proposed Mitigation Measures	Actor for Mitigation Measures	Regulatory Authority
1	Social Infrastructure / Service	• Prior notice to traffic police before the construction works. • Placement of traffic guides at each end of construction sections for smooth inducement of traffic. • Careful examination of Contractor's construction plan and schedule. • Setting detouring route if necessary. • Sufficient information disclosure such as construction period or work section to media such as television, radio, newspapers, etc. as well as utilization of internet media. • Socialization activity to local residents including distribution of leaflet or announcement letters or holding meetings if required. • Implementation of underground utility survey for existing water pipes, power lines, telephone lines and gas pipes not to cause damage on these utilities. • Adoption of trenchless method at crossing points of roads with heavy traffic and	Contractor	Police/ BWSSB/ Consultant

S. No	Impacts	Proposed Mitigation Measures	Actor for Mitigation Measures	Regulatory Authority
		railway crossings.		
2	Infectious Diseases	• Preparation of appropriate working health plan. • Training of working health for workers. • Biannual health camps for workers	Contractor	NACO/ KSAPS/ BWSSB/ Consultant
3	Occupational Health and Safety including communication plan	• Preparation of construction plan. • Training of construction workers. • Formulation of procedure to work in confined space. • Preparation of emergency safety plan. • Provide construction workers with sufficient personal. • Provide safety action items for fall / trips / electrical shocks / highest / scaffolding etc., • Protective equipment such as hard hats, earpiece, safety shoes, goggles, and others. • Emergency safety equipments such as Breathing apparatus, reviving apparatus, Vessels containing oxygen or air, Safety harness & ropes and Audio alarms for alerting workers at construction site. • Conduct explanation meetings on safety issues for local communities. • Install warning signs whereas the potential dangers are expected. • Erect temporary fence around high-risk areas to control public access and light them at night if that is on the regular roads used by the locals. • Assign construction staffs on or near places where construction vehicles are crowded to ensure safety.	Contractor	KSPCB/ BWSSB/ Consultant
4	Air Pollution	• Preparation of construction plan for control dust and particulate matter. • Examination of Contractor's construction plan especially on dust control and particulate matter. • Monitoring of Contractor's dust and particulate matter control.	Contractor	KSPCB/ BWSSB/ Consultant
5	Waste	• Preparation of construction plan for excavated soil and demolition waste.	Contractor	KSPCB/

S. No	Impacts	Proposed Mitigation Measures	Actor for Mitigation Measures	Regulatory Authority
		• Examination of Contractor's construction plan. • Monitoring of Contractor's management of excavated soil, construction debris.		BWSSB/ Consultant
6	Noise / Vibration	• Utilization of low-noise type construction machineries. • Temporary enclosure of the site during the construction works if necessary. • Instructing the Contractors to examine low noise/vibration construction methods. • Encouragement of idling reduction to the workers. • To avoid works at night and early morning at the sites close to residential areas, schools and hospitals. • Monitoring of noise level at facility boundaries.	Contractor	KSPCB/ BWSSB/ Consultant
7	Accident	• Preparation of appropriate construction vehicle operation plan to avoid concentration of machinery and vehicles in limited roads. • Allotment of traffic guide for proper control of traffic in order to minimize disruption to traffic flows. • The construction site should be enclosed with temporary fence to provide a visual barrier between the construction site and adjacent traffic. • Contractor's advance notification to communities in case of blocking traffic for transport of heavy equipment.	Contractor	Police/ BWSSB/ Consultant

18.3 Proposed Environmental Monitoring Plan (EMoP)

The Contractor shall carry out the Environmental Monitoring Plan (EMoP) as indicated below.

18.3.1 Construction Phase - EMoP

No.	Item	Location	Parameters	Method	Frequency	Implementing Agency/Responsibility
1	Air Pollution	• Facility boundaries at construction sites.	• Dust. • Particulates.	• Air Quality Meter. • Examination of daily or monthly	Monthly	Contractor

No.	Item	Location	Parameters	Method	Frequency	Implementing Agency/Responsibility
				report.		
2	Waste	• Construction sites for excavation works. • Construction sites for Backfill. • Final disposal site of construction debris.	• Type of construction debris. • Amount of construction debris. • Amount of excavated soil.	• Visual inspection. • Examination of daily or monthly report.	Monthly	Contractor
3	Noise / Vibration	• Facility boundaries at all ISPSs and WwTPs facilities. • All sewer network facilities.	• Noise level	• Measurement of noise level by decibel meter. • Examination of daily or monthly report.	Monthly	Contractor
4	Accident	• Construction sites.	• Safety measures. • Construction practice.	• Visual inspection. • Examination of daily or monthly report.	Monthly	Contractor

18.4 Construction Phase - Environmental Monitoring Forms

18.4.1 Air Quality

Method	Proposed Location	Frequency	Measured Value			
Air Quality Meter	• At construction sites.	Monthly (Examination of daily or monthly report)	Item	Yes	No	Measures Taken (Refer Notes)
			Dust			
			Particulates			
			Vehicle Emissions			
			Other (Specify:)			

Notes:

1. Sprinkling of surfaces, re-vegetation, and delayed stripping of vegetative cover where practical.

2. Water stockpiles and storage areas to prevent dust pollution.

Method	Proposed Location	Frequency	Measured Value
3. Cover trucks transporting construction materials to minimize spills. *4. Shall not overload vehicles.* 5. *Tune and service regularly all construction and transportation vehicle / equipment in order to prevent air pollution.*			

18.4.2 Waste

Method	Proposed Location	Frequency	Measured Value	
Visual inspection	• Construction sites for excavation works. • Construction sites for backfill. • Final disposal site of construction debris.	Monthly (Examination of daily or monthly report)	Item	Amount
			Type of construction debris.	
			Mount of construction debris.	
			Amount of excavated soil.	
			Location of final disposal sites of construction debris.	
			Location of final disposal sites of excavated soil.	

18.4.3 Noise / Vibration

Monitoring Item	Measured Value		Standards	Frequency	Measurement Point
	(Mean)	(Max.)			
Noise Level			Indian standard*	Monthly	Facility boundaries at construction sites.
** Indian standard as per Schedule III under the Noise Pollution (Regulation and Control) Rules, 2000 and amendment 2002*					

Area Code	Category of Area	Limits in dB (A)	
		Day time	Night time
A	Industrial	75	70
B	Commercial	65	55
C	Residential	55	45
D	Silence zone	50	40

Notes:

1) Daytime is reckoned in between 6:00 AM to 10:00 PM.

2) Night time is reckoned in between 10:00 PM. to 6:00 AM.

3) Silence zone is defined as areas up to 100 meters around such premises as hospitals, educational institutions, and courts. The silence zones are to be declared by the Competent Authority. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.

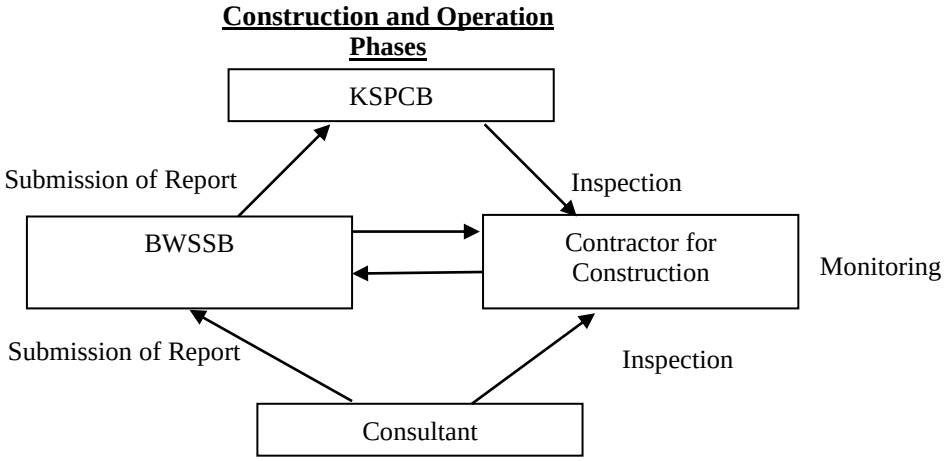
4) *Mixed categories of areas should be declared as one of the four above-mentioned categories by the Competent Authority and the corresponding standards shall apply.*

18.4.4 Accident

Item	Monitoring Place	Monitoring Method	Frequency	Monitoring Result
Adequate safety traffic control manners.	Construction sites	• Visual inspection. • Examination of daily / monthly report.	Monthly (Examination of daily or monthly report)	

18.5 Implementation Structure for Environmental Monitoring

The implementation structure for the environmental monitoring is shown in the following figure. The main actor of the environmental monitoring will be the Contractor who should undertake each project component of this Contract in the project phases of construction, operation and maintenance. The Consultant and BWSSB will inspect and supervise the Contractor's mitigation measures.



End of Part 18

Section 7A

Form of Technical Proposal

SECTION 7A: FORM OF TECHNICAL PROPOSAL

Name of the Contract: [*Insert as indicated in the tender*]

To:
Office of the Chief Engineer (Project),
Bangalore Water Supply and Sewerage Board
Cauvery Bhavan, 3rd floor,
K G Road, Bangalore 560 009,
Karnataka (India)

Sir,

We have examined the Conditions of Contract, Employer's requirements (Technical Specifications), Technical Schedules and Addenda Nos. _____ (*Insert nos.*), clarifications and the matters set out in the tender documents. We understood and checked these documents and not found any errors in them. We accordingly offer to design, construct, execute and complete and also operate and maintain the said Works and remedy any defects therein, in conformity with these documents and the enclosed Proposal. [*The following sentence is for Joint Ventures only*]. We hereby confirm that all partners of the joint venture are jointly and severally liable for execution of the Contract in accordance with the terms and conditions of the Contract.

We shall confirm all works, Plants, units, equipment including piping shall be designed as per the Technical specification in complete manner without any deviation.

We further undertake, if invited to do so by you, and at our own cost, to attend a clarification meeting at a place of your choice, for the purpose of reviewing our Technical Proposal and duly noting all amendments and additions thereto, and noting omissions there from that you may require, and to submit additional information that you require without any change to our price proposal as submitted with our tender or substance of the tender, in accordance with clause 22.1 of the ITT.

Yours faithfully

Signature _____in the capacity of _____duly authorized to sign bids for and on behalf of _____

Address: _____
_____
_____

Date: _____

NOTE: This form shall be filled and printed on the Company letter head, Signed, Scanned and uploaded. Failure to furnish the signed copy will lead to Non-Responsive Tender.

Section 7B

Technical Schedule

TECHNICAL SCHEDULE I

CONSTRUCTION PROGRAMME

The Tenderer shall submit a realistic construction programme which he proposes to adopt for executing the Works. This shall be in sufficient detail so as to show the order and duration of key activities required to carry out the Works (including each stage of mobilization of labour & equipments, setting up of site offices/ workshops/ consents and approvals, procurement, manufacture, pre-delivery inspection and testing, delivery to Site, construction, erection, testing and commissioning).

The Tenderer should pay particular attention to ensuring that the proposed programme is integrated with the Method Statement.

The construction programme shall be developed and presented on a commercially available project management software (such as Primavera, MS Project or equivalent), together with bar charts and CPM diagrams which clearly illustrate the critical path to achieve the desired results.

TECHNICAL SCHEDULE VI
SCHEDULE OF SUB CONTRACTORS
(To be completed by the Bidder)

The Bidder shall enter in this Schedule a list of the sub-components and approximate value (in terms of percentage of Cost of Construction Works) of the construction work for which he proposes to use subcontractors, together with the names and addresses of the proposed subcontractors. The Bidder shall also enter a statement of similar works previously executed by the proposed subcontractors, including description, location and value of work, year completed, and name and address of the Employer/ Employer's Representative. The Contractor shall provide evidence from the Employer/ Engineer that the subcontractor has previous successful experience in carrying out the works of a similar nature as the Contract. Notwithstanding such information, the Bidder, if awarded the Contract, shall remain entirely and solely responsible for the satisfactory completion of the Works.

Elements of Work	**Approximate Value of Work (INR)**	**Name and Address of Sub Contractor**	**Statement of Similar Works Previously Executed (Within last 5 years)**

TECHNICAL SCHEDULE VII

QUALITY ASSURANCE & QUALITY CONTROL PLAN

The Bidder shall provide copies of the company's standard rules and regulations regarding quality assurance and quality control procedures for works in general and works of a similar nature.

The Bidder shall provide its proposed Quality Assurance and Quality Control Plan in detail so as to demonstrate the procedures and tests that will be used to ensure that the quality concerns and requirements as set forth in conditions of contract, Quality Assurance as given in Volume 2, Technical Specifications are satisfactorily met.

The proposed plan will describe but not limited to:

- The type, frequency and procedure of tests to be done on sites;
- Type, frequency and procedure of tests to be done in pipe manufacturing units at site, if applicable;
- Type, frequency and procedure of tests to be done at manufacturers' locations outside the sites;
- All parameters to be measured in these tests; permissible limits of such parameters; details of laboratories to be established at sites; details of testing equipments & machines and their calibration schedules
- Details of the Bidder's internal systems for assuring quality control at the manufacturers' works outside the sites;
- Details of qualifications and experience of the Quality Control professionals to be deployed for the entire project; and
- The systems of Quality Audit to be instituted for systematic and professional management as well as adherence with the highest standards of quality of all construction works.
- All the tests of samples taken from the site are proposed to be done through recognized test houses of international standards and number of samples and frequency of sampling of materials brought to the site and the products manufactured at site shall be as per I.S. Specifications. All such samples shall be taken in the presence of Employer's authorized representatives or the Engineer.

The Bidder shall provide separate descriptions of its proposed QA/QC plan during the construction phase, and the subsequent operations and maintenance phase.

This will be an initial QA/QC plan which will address to basic requirements of Quality control and Quality assurance of the works.

TECHNICAL SCHEDULE VIII

ENVIRONMENTAL MANAGEMENT PLAN

(To be completed by the Bidder)

The Bidder shall provide his proposed Environmental Management Plan in detail so as to demonstrate the procedures that will be used to ensure that the environmental concerns and requirements as set forth in Part 3 (Refer Section 3.25) and Part 18 are satisfactorily met.

The Environment Management Plan shall identify the potential environmental impacts from the various construction and operations and maintenance activities to be undertaken in the Contract and set out in detail the approach that will be adopted in mitigating these environmental impacts to ensure that the residual impacts are minor and confined to a short period.

While preparing the proposed Environmental Management Plan the Bidder shall consider but not be limited to the following:

- The Bidder shall pay attention to the methods of materials delivery, storage, usage and disposal; equipment usage; and site activities to ensure they have minimal impact on the environment,
- The Bidder shall propose only environmentally safe products and practices in performing his works, and
- The Bidder shall comply with all of the statutes regarding environmental effects.

The Bidder shall provide separate descriptions of its proposals for minimizing any adverse environmental impacts/effects during the construction phase and the subsequent operations and maintenance phase.

This will be an initial Environmental Management Plan (EMP) which will address all moderate and significant negative impacts of the construction and operation and maintenance activities to be performed in the contract.

TECHNICAL SCHEDULE IX

SAFETY PLAN

(To be completed by the Bidder)

The Bidder shall provide his proposed Safety Plan in detail so as to demonstrate compliance with the requirements set forth in Section 3.26 of Part 3- General Requirements are satisfactorily met.

The Safety Plan shall include a policy statement signed by the CEO or equivalent authority of the Organization declaring that Safety and loss prevention shall be given the highest practicable priority in all aspects of the Contract.

The Bidder shall describe his proposed Safety Plan which shall be developed to ensure zero fatal accidents and zero hazardous incidents/occurrences in all construction works, including descriptions of the company's standard policies and procedures regarding its site organization and procedures implementations, methods and frequency of conducting safety audits/inspection at the Site(s), record keeping and reporting includes compliance reports and monthly reporting, timely corrective action implementation for the issues, supervising and monitoring to sustain the established safety management system, conducting safety review meetings, providing safety training for its personnel as required for all major critical activities of the sites, issue and mandatory use of safety equipment and penalties for non-compliance to be adopted within contractor organizations, keeping the plant and equipment's well maintained and details of the qualifications and experience of the Bidder's proposed Accident Prevention Officer(s) to be deployed at the Site(s).

The Bidder shall provide separate descriptions of its proposed Safety Plan during the construction phase and the subsequent operations and maintenance phase.

This will be an initial Safety Plan which will address to the Health and Safety of the all persons entitled to be at Site(s) including the Employer's personnel.

TECHNICAL SCHEDULE XI

STATEMENT OF DEVIATIONS FROM THE TECHNICAL SPECIFICATIONS

(To be completed by the Bidder)

Name of the Bidder

The Bidder shall describe all proposed deviations from the Specifications set out under Volume 2, Section 7, clause by clause, in this Schedule.

The Bidder shall note that the Specifications given in the Bid Document are the minimum acceptable, and that only standard that is better / higher than the ones referred to in the Bid Document will be acceptable. Acceptance of the Bid shall not be construed as approval by the Employer of any deviations from the Technical Specifications. All details will be subject to the approval of the Engineer during execution of the Contract.

Sub-Section Number	Title of Sub-section	Clause No.	Specification as per Bid Document	Deviation & Specifications Proposed with standard code reference	Reasons for Deviation

The Bidder hereby certifies that the above-mentioned deviations are the only deviations from Specifications set out under Volume 2, Section 7, and that he accepts all the remaining technical requirements of the Bid Document. Further, the bidder shall also accept that there is a no deviation from the treatment process and treatment units specified under Volume 2, Section 7 of the bidding document.